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FOREWORD.

The pleasing reception afford the first volume of "Popular Science Talks" is warrant enough for the issuance of this, the second volume.

The lectures which constitute the volume represent the effort of the Philadelphia College of Pharmacy and Science to contribute to the educational welfare of the community at large by means of popular scientific discussions.

These talks were delivered to large audiences by members of the Faculty of the institution and were abundantly illustrated by experiments, lantern slides and specimens. They were subsequently broadcast from several Philadelphia radio transmitting stations.

Given in a form which is simple and understandable they are of particular value to those who are interested in scientific subjects in general and they are not without value to persons who are technically trained along particular lines.

It is the intention of the College to continue this publication and an outline of the series of lectures for the coming season is printed at the end of the volume.

THE ROMANCE OF DRUGS.

By Charles H. LaWall, Ph. M., Phar. D.
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Part I. Vegetable and Animal Drugs.

OUR FATHERS OF OLD.

Excellent herbs had our fathers of old—
    Excellent herbs to ease their pain—
Alexanders and Marigold,
    Eyebright, Orris and Elecampane.
Basil, Rocket, Valerian, Rue,
    (Almost singing themselves they run)
Vervain, Dittany, Call-me-to-you—
    Cowslip, Melilot, Rose of the Sun.
        Anything green that grew out of the mould.
        Was an excellent herb to our fathers of old.

Wonderful tales had our fathers of old—
    Wonderful tales of the herbs and the stars—
The Sun was Lord of the Marigold,
    Basil and Rocket belonged to Mars.
Pat as a sum in division it goes—
    (Every plant had a star bespoke)—
Who but Venus should govern the Rose?
    Who but Jupiter own the Oak?
        Simply and gravely the facts are told
        In the wonderful books of our fathers of old.

Wonderful little, when all is said,
    Wonderful little our fathers knew.
Half of their remedies killed you dead—
    Most of their teaching was quite untrue—
"Look at the stars when a patient is ill,
    (Dirt has nothing to do with disease),
Bleed and blister as much as you will,
    Blister and bleed him as oft as you please."
        Whence enormous and manifold
        Errors were made by our fathers of old.

Yet when the sickness was sore in the land,
    And neither planets nor herbs assuaged,
They took their lives in their lancet-hand
    And, oh, what a wonderful war they waged!
Yes, when the crosses were chalked on the door—
    Yes, when the terrible dead-cart rolled,
Excellent courage our fathers bore—
    Excellent heart had our fathers of old,
        None too learned, but nobly bold
        Into the fight went our fathers of old.

If it be certain, as Galen says,
    And sage Hippocrates holds as much—
"That those afflicted by doubts and dismays
    Are mightily helped by a dead man's touch,"
Then, be good to us, stars above!
    Then, be good to us, herbs below!
We are afflicted by what we can prove,
    We are distracted by what we know.
        So—ah, so!
            Down from your heaven or up from your mould,
            Send us the hearts of our fathers of old.

Songs from Books—Kipling.

When our first rude ancestors, in the dawn of recorded time, found that certain plants or portions of plants could be used in alleviating human suffering or correcting human ills, there was then begun a search for remedial agents or drugs that could be used to cure disease which has resulted in the accumulation of a mass of mostly useless and forgotten lore exceeding that upon any other single subject concerning which man has reduced his thoughts to writing.

What matters it that the word "drug," originally meaning a dry herb, has been enlarged in its significance so that it now includes anything in the animal or mineral kingdoms as well as in the vegetable kingdom? What does it signify that, through the many useless remedies that have had their vogue and then been discontinued after the public has been well supplied, the word has come to be employed in a derogatory sense in the expression "a drug on the market"? What about the sinister modern use of the word in the expressions "drug addict" and "drug habit"? This latter unqualified use is unjustifiable and arouses proper resentment from those who do not wish to see the part confused with the whole, for "narcotic drug" or "dope" is what is really meant in such cases and discredit is cast upon a group of useful substances. How many who use the word "cure" know that in its original employment and etymology it meant only "to care for" and not of necessity "to relieve"?

If we search these almost forgotten pages of the past we find comedy and tragedy, truth and error, fiction and fact, intermingled in such fragmentary forms as to remind us of the broken pieces of utensils, weapons and other discarded materials unearthed in the

kitchen middens of prehistoric civilizations, and the searcher is intrigued by the visions of the past that flash before him like scenes from a screen romance and is stimulated to share the tale with others.

Entirely apart from the equally fascinating chapter on magic and the employment of occult practices in medicine, which must be passed over entirely for the present, the searcher finds such a wealth of material spread before him that a subdivision is found

EBERS PAPYRUS.
Wooton's Chronicles of Pharmacy. MacMillan & Co.

necessary; consequently, the first chapter only will be taken up at this time, *i. e.*, the romance of vegetable and animal drugs, leaving for future occasions the equally attractive chapters on the romance of drugs from the mineral kingdom and the romance of medicinal preparations.

Amulets and oracles, witches and warlocks, gnomes and elves, sylphs and salamanders, amber beads, coral necklaces, strings of Job's tears, bags of asafetida and camphor, and the abracadabras of the past must give way for the discussion of the more tangible,

yet at times, equally mysterious effects of what mankind has come to call drugs.

We have no direct knowledge of what substances were used as drugs by our troglodytic ancestors who lived in the paleolithic, neolithic or iron ages. Our oldest manuscript on the subject is the Ebers Papyrus,† which dates from 1500 B. C., a time shortly after the bronze age and almost contemporaneous with Moses. In this ancient document more than seven hundred remedies are mentioned, of which but a few are identifiable as now being in use.

Reference is made in this papyrus to an older work on the same subject, which would carry our knowledge of drugs to about 4000 B. C. if the older manuscript were ever to be discovered. Among these remedies which were in use more than 3500 years ago are poppy, castor oil, gentian, aloes, hemp, squill, myrrh, saffron and henbane. Records of ancient India show that there were in use in that country alone more than five hundred drugs, not one of which was of European origin and few of which are now known and used.

The startling thing about the story of drugs is that there is little continuity between the past and present except for a mere handful of medicinal substances that have come down the ages with their reputations unimpaired. Each century, nay, each generation, has had its fads and fancies in drugs and cures, and yet we deceive ourselves if we take pride in our own age being different in this respect from that of the rude, unlettered people of the past, on account of our superior education. As Kipling says:

> "We are distracted by what we believe,
> We are afflicted by what we know,"

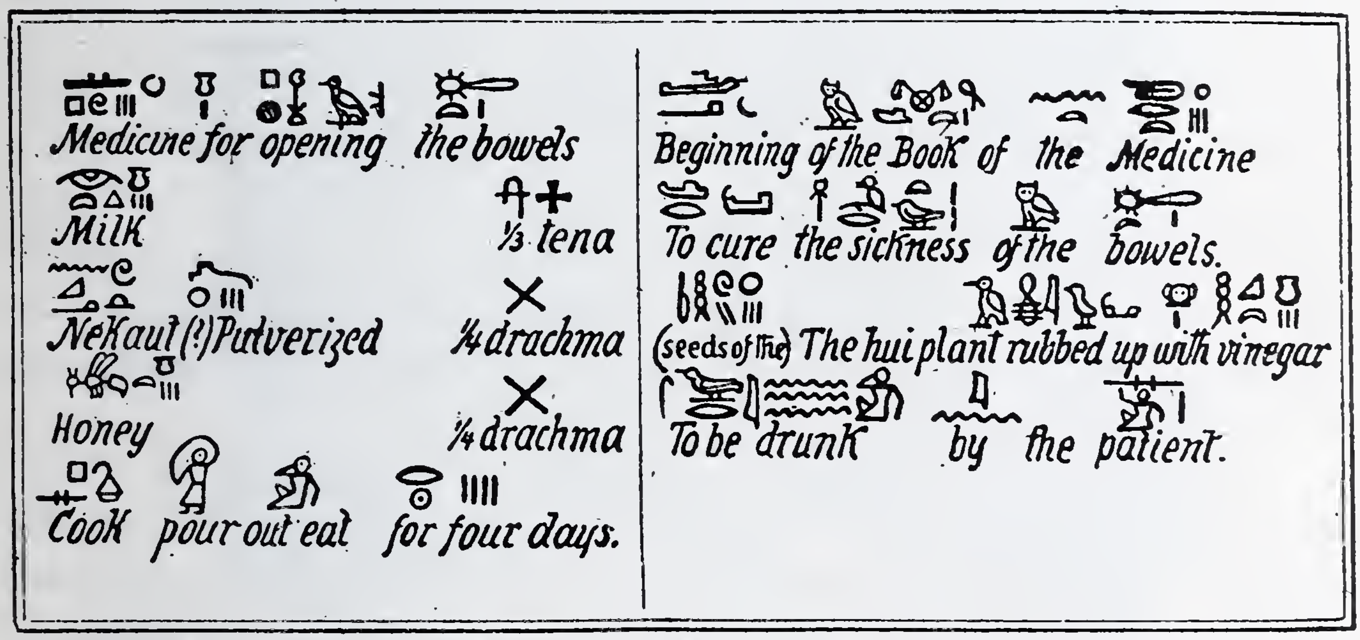
and in respect to drugs and cures we are the victims of cults and "isms" camouflaged by pseudo-science and enveloped in language of mysterious and high sounding unintelligibility, so that our time, with all its scientific advancement will probably be referred to by future generations as the age of credulity. It is a great deal more enjoyable, however, to point out the faults and inconsistencies of

†The Edwin Smith Papyrus, recently discovered, is stated to precede the Ebers by about one hundred years.

others than to deal with our own, so let us go back and wander up some of the bypaths of literature in this fruitful field.

The drugs described by the classical authors of the past are delightfully vague and wonderfully effective. The formulas for Chiron's healing ointments were never divulged. The identity of the anodyne and astringent root with which Patroclus treated Aeneas' frightful wound has never been established. Even the Nepenthes of Homer cannot today be duplicated by modern scientific knowledge. Of its effects we are told in circumstantial detail:

> "Whoe'er his wine so medicated drinks, he shall not pour
> All day the tears down his wan cheeks, although
> His father and his mother both were dead;
> Nor even though his brother or his son
> Had fallen in battle and before his eyes."



LIBERAL TRANSLATION OF A PASSAGE FROM THE EBERS PAPYRUS.

Guesses as to the identity of this wonderful gloom dispeller have been made by various authorities, and among the drugs mentioned are opium, henbane and Indian hemp, as well as the now discarded mandragora which was so wonderfully esteemed in the early days.

The famed potion of Friar Laurence which caused the counterpart of death in Juliet for two and forty hours has no duplicate in the medicine of our time.

The caduceus or serpent twined about a staff was the symbol of Aesculapius. The serpent has at many periods been selected as

typifying wisdom and in this particular instance the familiarity with which Aesculapius handles the reptile is supposed to convey the idea of his power over its poisonous bite.

Toxicology, or the study of poisons, constituted an important part of the early knowledge concerning drugs. The word "pharmakon" in Greek, now the root word of pharmacy, originally meant a powerful drug or poison. The search for an alexipharmic or universal antidote to all poisons occupied the attention of some of the wisest and greatest of their times.

One of the earliest of these was Mithridates, king of Pontus, who in some of his methods antedated modern scientific procedures in the manufacture of present day biological products, for he fed ducks on toxic principles and used their blood in subsequent attempts to confer immunity from such poisons. He evolved a wonderfully complicated formula for a universal antidote which was called "Theriaca," and which was used for more than a thousand years in various forms and modifications. The esteem in which this preparation was held during this long period was probably due to the tale which originated at the time of Mithridates' defeat by Pompey, to the effect that, finding himself about to fall into the hands of the enemy he attempted to take his own life by swallowing poison. This, however, had no effect, due to his having developed such a high degree of immunity, and he was compelled to command one of his soldiers to kill him to avoid being captured.

It is further stated that the capturing of the formula for Theriaca by Pompey was looked upon as the most valuable fruit of the victory. In medieval times this preparation was so highly regarded that its compounding was carried on as a semi-public function of great importance to the community, and the physicians inspected the ingredients and supervised the preparation of the remedy by pharmacists.

The effect of poisonous herbs upon the lower animals must have been frequently observed by our forefathers, for so many of our herb names carry the terminal syllable "bane," as in cowbane, wolfsbane, dogbane, leopardsbane, henbane, bugbane, and others still in common use.

The Mesopotamian worshippers of Astarte had begun the association of the heavenly bodies with certain earthly substances many centuries before the Christian era. We still retain this thought in our present name of the metal mercury, which is still the name of

the planet as well. It was easy to carry this idea still further and to associate the planetary influences with the action of drugs.

We find Pliny in the first century of the Christian era thus describing the proper method of collecting vervain, then highly esteemed as a remedy, now deemed of little worth:

> "After appropriate libations of honey, the plant is to be gathered at the rising of the dog star, when neither sun nor moon shone, with the left hand only. When thus collected it is said to vanquish fevers and other distempers, acts as an antidote to the bites of serpents, and, when worn, as a charm to conciliate friendship."

THE PREPARATION OF THERIACA.
From Follies of Science. Pharm. Rev. Pub. Co.

We smile indulgently and associate such superstition with the ignorance of that early period, and yet, I personally have been seriously told by a relative of a Pennsylvania German herb doctor that in collecting boneset, if one pulls the leaves off with an upward motion the effect of the drug when taken will be emetic, while if a downward motion is employed to remove the leaves the effect will be cathartic.

The peak of misbelief with regard to occult influences affecting the properties of drugs was in the time of Robert Turner and of Nicholas Culpeper in the seventeenth century. Turner wrote "God

hath imprinted upon the plants, herbs and flowers, as it were in hieroglyphics, the very signature of their virtues." The doctrine of signatures, as this belief came to be called, professed to find resemblances either between the plant and the cause of disease or affliction, as exemplified in the names "feverwort," "boneset," etc., or between the plant and the part of the body affected, as in "liverwort," "heartsease," etc. Many other of our common plant names still reflect this curious superstition. Some of the elaborate applications of this doctrine are amusing in the extreme, as is shown by the following one concerning walnuts, taken from an old herbal:

> "Walnuts have the perfect signature of the head: the outer husk or green covering represents the pericranium or outward skin of the skull, whereon the hair groweth, and, therefore, salt made of those husks or barks are exceedingly good for wounds in the head. The inner woody shell hath the signature of the skull, and the little yellow skin or peel that covereth the kernell is like the thin scarf that envelopes the brain and therefore it is very profitable for the brain and resists poisons, for if the kernell be bruised and moystened with the quintessence of wine and laid upon the crown of the head it comforts the brain and head mightily."

Astrological relationships between plants and stars, as quoted from Pliny's time, had their chief exponent in Nicholas Culpeper, who in the preface to his herbal says:

> "First—consider what planet causeth the disease.
> Second—consider what part of the body is afflicted by the disease.
> Third—consider by what planet the afflicted part of the body is governed.
> Fourthly—You have in this book the herbs for cure appropriated to the several diseases whereby you may strengthen the part of the body by its like, as the brain by herbs of mercury, the breast and liver by herbs of Jupiter, and the heart and vitals by herbs of the sun, etc."

Kipling evidently drew much of the inspiration and information for his "Fathers of Old" from Culpeper, for this curious volume is full of the virtues of "Alexanders and marigolds, eyebright, orris and elecampane," and where Kipling says,

> "Who but Venus should govern the rose
> Who but Jupiter own the oak?"

he quotes almost verbatim, for in Culpeper's book it is said of the rose "damask under Venus," and under the oak "Jupiter owns the tree."

The oldest source of knowledge of Anglo-Saxon plant lore is the "Leech Book" of Bald, dating from the tenth century, in the time of King Alfred, who, it will be remembered, was a better king than a cook. Back in this time the doctrine of signatures had not yet appeared but there was much in the way of incantations

NICHOLAS CULPEPER.

Wooton's Chronicles of Pharmacy. MacMillan & Co.

and rites, both pagan and Christian, as is shown by the following quotation from this ancient manuscript:

> "Against dysentery, a bramble of which both ends are in the earth, take the nether root, delve it up, cut nine chips with the left hand and sing three times the *Miserere mei Deus,* and nine times the *Pater noster;* then take mugwort and everlasting, boil these worts and the chips in milk till they get red, then let the man sip at night fasting a pound dish full, let him rest himself soft and wrap himself warm; if more need be let him do so again, if thou still need do it a third time thou wilt not need oftener."

The Lacnunga, dating also from the tenth century, is another interesting Saxon drug and herb manuscript, which is noticeable for the "vers libre" style in which the virtues of the herbs are proclaimed. The following example is a description of the common herb now known as "Achillea" or "yarrow," once greatly extolled, now held to be of little value:

> "Eldest of worts
> Thou hast might for three
> And against thirty
> For venom availest
> For flying things
> Mighty against loathed ones
> That through the land rove."

The ancient Irish Druids, in whom were combined the roles of priest, physician and seer, left an interesting legacy of medical lore concerning both plant and animal products. Manuscripts in the early Irish language have been found, dating from about the same period as the Leech Book of Bald, and containing much the same sort of material. A Celtic manuscript of the fourteenth century contains several recipes of unusual character, for baldness:

> "Let calcine a raven, his ashes boil in sheeps' suet, and rub to the head, it cures."
>
> "With mice fill an earthen pipkin, stop the mouth with a lump of clay, and bury it beside a fire, but so as the fire's too great heat reach it not. So let it be for a year, and at the year's end take out whatever may be found therein. But it is urgent that he who shall lift it have a glove on his hand, let at his fingers' ends the hair come sprouting forth."

The advertising claims of modern hair restorers seem modest in comparison with this.

The oldest illustrated manuscript herbal is the Herbarum Apuleii Platonici, of which the Saxon edition of the tenth century is a translation of a Latin work of the fifth century, of which the original has never been discovered.

Of the printed herbals, the most noteworthy books on drugs of the sixteenth and seventeenth centuries, there were a great number and variety. Turner's (1551), and Culpeper's (1652) have already been mentioned. Others of importance were: Bancke (1525), Carey (1550), Treveris (1526), Gerard (1597), Parkinson (1629),

Cole (1656), Salmon (1710), and Tournefort (1716). These were all printed in English.

Of the herbals in other languages, of which quite a number are known, the most famous is that of Monardes (1659). Monardes was a Spanish botanist and explorer who contributed the first herbal of the New World. His work contains the earliest published account of the use of tobacco by the Indians and the first accurate description of the plant itself.

MATERIA MEDICA OF THE FIFTEENTH CENTURY.

From Follies of Science. Pharm. Review Pub. Co.

The sixteenth and seventeenth centuries, too, saw the beginning of many of the great botanical gardens of the world, some of which are still in existence. The following cities are on the honor roll in this respect, the accompanying figure being that of the year in which the garden was instituted in each case: Padua (1533), Florence (1544), Bologna (1547), Paris (1570), Montpelier (1598), Jena (1628), Oxford (1632), Upsala (1637), Chelsea (1673), Edinburgh (1675), Leyden (1677), Amsterdam (1682), and Utrecht (1725).

The first botanical garden in the new world was established privately in Philadelphia in the eighteenth century by John Bartram.

These centuries following after the discovery of America were the days when sick cattle or humans were often reputed and believed to be "elf shot," and much of the efficacy of drugs was directed to the cure of such afflictions. As Kipling says of some of these early authors, again to quote from "Our Fathers of Old,"

> "Most of their teaching was quite untrue,"

but there are those today who would still hold with the author of Treveris' "Grete Herball" in 1529, that:

> "It is impossible for them that drynketh overmuche water in theyre youth to come to ye age that God hath orderyed them."

DEMONS OF DISEASE OF FIFTEENTH CENTURY.
Peters' Pictorial History of Pharmacy. G. P. Englehardt & Co.

The majority of the highly esteemed herbs and medicines in any country were of local origin, but rare and valuable products of the Orient had found their way into medical practice, and in the twelfth and thirteenth centuries we find drugs vieing with spices as important objects of commerce in Venice, that remarkable republic, which could truly boast that for a thousand years she had never been bankrupt, never paid tribute to a foreign prince, nor been occupied by a foreign army, although she was denounced by her rivals as a mercenary nation of shopkeepers.

Marco Polo had brought back from his travels accounts of camphor and of Turkey rhubarb, then worth their weight in gold. Ambergris, musk, sandalwood, storax, galangal, spikenard, saffron, benzoin, frankincense, scammony, aloes, manna, galbanum, asafe-

tida, myrrh, opium and opoponax, some of them drugs and others valued ingredients in incense, are all mentioned in merchandise lists of fourteenth century Venetian commerce.

In the sixteenth century the population of Venice was equal to that of London. The Portuguese and Spaniards had by this time, by their discoveries of the two great all-sea routes to the Indies, acquired a monopoly of the traffic in spices and drugs, and two or three voyages each with a tenfold return of the investment would bring wealth to those who risked the perils of such adventure, or who could engage others to do so in their stead.

> "All to stuff the sunset in our old black galleon
> All to seek the merchandise that no man ever found."

was the impelling force of much early exploration and conquest.

The Muscovy Company and the Levant Company of England were examples of organized effort to offset the then growing domination of the eastern trade by Holland. This was the period when Drake's flagship returned from the successful circumnavigation of the globe:

> "A little weed clogged ship
> Grey as a ghost glided into the sound
> And anchored, scarce a soul to see her come
> And not an eye to read the faded scroll
> Around her battered prow—The Golden Hind."

What stirring deeds are recalled by the sound of the names with which the doughty mariners christened the ships that charted the seas that safely carry our commerce of today—Bonaventure, Malice Scourge, Ascension, Red Dragon—all are reminiscent of the dauntless acts of times when the bravest men who ever lived sailed the then uncharted seven seas in search of gold and glory, and brought back to Europe drugs of mystery and renown.

The school of medicine at Alexandria had, centuries before, established principles called the "Tripod of Medicine," which should govern the treatment of disease. Observation, history and analogy are sound factors even in our time, but, through the many years during which the literature had accumulated, much of the observation was incorrect, the history fabulous, and the analogy untrustworthy. Even today these factors are not always reliable. Small wonder is it then, that in the byways which we shall now search out

we shall find ourselves, at times, in the therapeutic graveyards of the past.

It is impossible to do more than discuss very briefly a few of the drugs of prominence or interest in the time that is at our disposal. A few from the old world, including some that have come down from the time of the Pharaohs and their contemporaries, and a few from the new world that have either found a permanent place in modern medicine or are noteworthy for some other reason.

Aloes. It is doubtful whether the aloes of the Papyrus Ebers is the same drug that is meant in our own time. It is certain that the aloes of the Bible is not the same, for what is meant there is a wood used for incense and sharing only the property of bitterness with the genuine drug, which is the solidified juice obtained by evaporation of the sap of the leaves of a plant resembling our well-known century plant. The real aloes is not mentioned either by Hippocrates or Theophrastus, who were early writers on drug subjects.

Dioscorides, in the fourth century B. C., describes it and states the dosage to be one drachm for a gentle purge and three drachms for full cathartic effect. The modern dose is less than one-tenth of that amount. Celsus, called the Cicero of physicians by later historians, states in the first century of the Christian Era, that "Aloes is valuable for city men, and men of letters," recognizing the common affliction of the sedentary at that early period. It is an ingredient of the oldest compound remedy which is still in use unchanged, a mixture of aloes and an aromatic bark called "canella," although the meaning of the name "Hiera Picra" (literally "Sacred Bitters"), has long since lost its significance.

Aloes originally came from an island Socotra (Sokotra), lying southeast of the Gulf of Aden. The name of the island is said to be derived from the Latin *Succus citrinus,* meaning yellow juice, in recognition of its principal product. Aloes was so highly esteemed as a drug in Alexander's time that when he returned from his conquest of Persia and India, he came by way of Socotra, removed the original inhabitants, and replaced them by a Greek colony intended to ensure a sufficient supply of the drug for future years. This was done upon the advice of no less a person than Aristotle, the philosopher. It is stated that these Greeks later became an important Christian colony. In the seventeenth century the entire trade in aloes was controlled by the British East India

Company, who dealt directly with the King of Socotra and usually purchased the entire stock. The plant had been introduced into Europe as an ornamental garden plant and was known by the name of "Sempervivum." The island is now owned by Great Britain and is still the source of the widely-known and important variety of aloes known as Socotrine aloes.

The Arabians carried the fame of aloes down to the middle ages and it was one of the drugs recommended to Alfred the Great by the Patriarch of Jerusalem in the tenth century and is mentioned in the Leech Book of Bald. In the eighteenth century a West Indian variety known as Barbadoes aloes appeared (now obtained from Curacoa and usually known by that name at present), and a South African variety known as Cape aloes, appeared in the world's commerce. All of these varieties are now used in medicine.

Among the curious errors which existed with respect to this drug, it is stated by an early author (Pomet, 1701), that when the flowers open they make a great noise like the report of a gun. Through these many centuries aloes has continued to hold a prime place in medicine and is employed in more than twenty official preparations at the present time in the United States Pharmacopœia and National Formulary.

Opium. One of the most useful of drugs and at the same time one which, when misused, is a terrible master; one of the mysterious drugs of the remote past over which wars have been fought almost in our own time. It is the dried juice of the unripe poppy capsule, that name which brings visions of the scarlet flowers of Flanders fields, although as a matter of fact, the opium poppy has a pink or purplish-pink flower of much larger size than the red poppy.

The word "opium" means simply "juice." Formerly known as Opium Thebaicum, the latter name alone came to be used for centuries as a synonym of the drug. The ancients of Theophrastus' time described a variety known as "meconium," which was made from the juice of the crushed plant and was much inferior in narcotic quality to that obtained from the capsules. Probably other drugs were known by the same name, for the opium of Hippocrates was described as having purgative properties which the real opium does not possess. Dioscorides describes the opium which we know and also discusses its adulterants.

Galen rarely used opium as such but speaks highly of "Theriaca," which owed its principal value to opium. Paracelsus, noted

as the originator of laudanum, owed much of his fame to his boldness in the use of this drug. Van Helmont employed it so frequently that his contemporaries called him "Doctor Opiatus." Sydenham said, "Among the remedies which it has pleased Almighty God to give to man to relieve his sufferings, none is so universal and so efficacious as opium." One of King Manuel's Portuguese agents in the Orient speaks of it in a letter in 1516 as "A great article of merchandise," and that "Kings and lords eat of it." In former times, the Sultans of Egypt had sent presents of opium and Theriaca to the Doges of Venice and the sovereigns of Cyprus. There was long a tradition of a white variety of opium which the Turks are said to have kept for themselves.

The Arabians were the greatest users of opium until the eighteenth century, some authorities stating that the prohibition of wine by Mohammed was the impelling cause of the general use by the Arabs of such narcotics as opium and "hashish."

The Chinese never saw opium until the ninth century, when it was taken there by the Moors for use in dysentery, the prevalent disease among a people so careless in the use of fertilizers and of the purity of their drinking water. The smoking of opium in China did not begin until late in the seventeenth century. Within 100 years it had undermined the morality of the people and was recognized as a plague. The importations of opium by the Chinese were small until 1787, when the British East India Company, seeing an increase in the trade, established supply depots in Larks Bay south of Macao, an island adjacent to Hong Kong. This so stimulated the use of opium for smoking, as well as for medicinal purposes, that the Chinese Government was compelled to take action, and the first edict against the practice was issued in 1796. The Chinese authorities complained of these ships putting in at Larks Bay, saw the growing peril of the use of narcotics by the people, and in 1820 forbade any vessel containing opium to enter the ports of Canton, a short distance north. This led to contraband trade between the East India Company and Chinese officials, and eventually, in 1840, to the struggle between Great Britain and China, known as the "Opium War," which culminated in the treaty of Nanking in 1842, by which five Chinese ports were opened to foreign trade and opium was declared a legal article of commerce. Seldom in history has the weakness and need of a nation been exploited so disgracefully as has been the case with opium in China and it is a shameful page

in the history of the Island Empire upon whose possessions "the sun never sets."

Another interesting chapter in the history of opium is that in which Derosne and Serturner, two apothecaries working independently, one in France and the other in Germany, in the early years of the nineteenth century, opened up the great period of plant chemistry by the discovery of the narcotic principle of opium, named "Morphium" by Serturner, after Morpheus the God of Dreams. In our day and times this narcotic drug and all of its preparations and derivations are under strict Governmental and State supervision for the protection of the people.

Camphor. A drug derived by distillation from the wood of certain Eastern trees, camphor, or camphire, as it was frequently spelled, was one of the most costly products imported by the Venetians, who maintained a monopoly of it for centuries. It does not appear to have been known to the ancient Greeks and Romans, nor even to the Chinese until after the sixth century, although the world's principal supply now comes from Formosa. Early travelers brought back erroneous tales of its flowing from trees as a white gum which solidified at the foot of the trees in little cakes. In Burton's "Arabian Nights" he speaks of the Lord of the Land of Camphor, and Marco Polo tells of its selling for its weight in gold. There was great confusion in early times regarding camphor because of the fact that it was obtained from two very dissimilar trees growing in different lands.

The laurel camphor, now the principal source, is cultivated in China, Japan and Formosa, and also in Florida. The Borneo camphor, as the other variety was called, came from the Malay States, usually through India. In 1350 the Great Khan of China sent an embassy from Pekin to Pope Benedict XII, with gifts of silk, gems, camphor, musk and spices. The Arabs were great users of the drug and often added it as an ingredient to their cooling drinks. At present it is used as a moth repellant as well as in medicine. The quantity of some drugs purchasable for a certain amount of money, was of importance, according to one medical superstition. When a person purchased camphor to put in a bag to wear suspended from a cord encircling the neck to keep away disease, it was necessary to purchase ninepence worth, in order to have any efficacy.

In our time it has been found possible to make camphor synthetically, for the needs of the civilized world for moving pictures is associated with celluloid, and celluloid is a combination of ingredients in which camphor is an important factor. It is a far cry from Marco Polo to Charlie Chaplin, but camphor bridges the gap successfully.

Indian Hemp. Cannabis Indica, Bhang, Siddhi, Guaza, Marihuana, Gunjah or Ganjah, Churras, Majoon, probably better known to many as "hashish," from which our word "assassin" is derived, according to some etymologists, is another drug which was not known to the ancient Greeks or Romans, unless it was an ingredient in Nepenthes. It is a product of the common hemp plant, whose fibres are used for rope and the seeds of which are used as food for birds and the oil as an edible oil as well as having uses in the arts.

The female plant secretes a resin at the time of inflorescence, and it is the massed flowering tops collected before the seeds are matured that constitutes the drug as used in commerce and medicine. It was once believed that only the Oriental plant was physiologically active but the domestic product is now recognized as of equal value with the imported. It is a native of Persia, later introduced into India, where it has been cultivated for many centuries. It plays an important part in Oriental literature and is frequently mentioned in the "Arabian Nights." In one of these references King Omar casts the Princess Aboriza into heavy slumber with a piece of "bhang," so concentrated that if an elephant smelt it he would sleep for a year.

Indian hemp as a habit-forming drug does not seem to appeal to races of the Occident. Medical writers have frequently called attention to the fact that the astonishing effects produced by its use in India are not capable of duplication in cooler climates. Of the Arabian "hasheesh" eater it is said that "it seemeth to him that the world is in the hollow of his hand." The Arabian poets speak frequently of the emerald cup, referring to the brilliant green color of the best quality of the drug and the preparations thereof. In India it has been called "Indrasana" or Indian hemp.

The use of this drug is very carefully controlled in this country and is subject to Federal regulation as regards declaration of its presence in medicines sold to the public. The growing of the plant is forbidden in some western States on account of the illicit

and dangerous use of the drug when mixed with tobacco and made into cigarettes, such cigarettes bringing from ten to fifteen cents apiece in the underworld, where they are in demand.

Rhubarb. This dried root of a plant related to our garden rhubarb is undoubtedly one of the oldest of the drugs whose history has come down to us uninterruptedly from the remotest past. Originating in China and known there before Cheops had erected the great pyramid at Gizeh, it takes its name from the classic appellation of the River Volga, then called "Rha," the contact point where this product of the Eastern world was delivered to the people of the West. The Rha Ponticum or domestic variety of the drug was considered inferior to the Rha Barbarum, or foreign variety.

Rhubarb was sent from China through Mongolia to Bokhara, thence either by caravan to the Black Sea (Mare Ponticum), or by water route down the Indus and through the Persian Gulf to Arabia. Later, as different trade routes developed, there came to be known three kinds of rhubarb, all of which started from the same country of origin but were named from the place of distribution.

Russian rhubarb was transported over the barren steppes of Central Asia through Turkestan and over the Caspian Sea to Southern Russia. This rhubarb was inspected, selected, and restricted at various distribution points like Moscow and St. Petersburg.

Turkey rhubarb came overland to Bokhara and then down the Indus or the Persian Gulf to the Red Sea and then through Asia Minor to Turkey.

Chinese rhubarb was shipped direct to Europe from Canton, the only Chinese port open to European commerce prior to the Opium War Treaty in 1842.

The risk and enormous expense of overland transport made rhubarb one of the rarest drugs of ancient times. Twelve times as expensive as benzoin, four times as valuable as saffron, twice as costly as opium, it was a drug fit for the use of royalty. In our time it costs less than a dollar a pound and nobody remembers or cares about its history. Its present popularity is attested by the fact that twenty-six preparations of rhubarb are officially recognized in the United States Pharmacopœia and National Formulary.

Senna. This leaf drug is associated with the early medical

practice of India, Assyria, Egypt and Phoenecia. Found in the tombs of the Pharaohs, it has been a popular home remedy from that period down to the present. It was introduced into European medical practice by the Arabs in the ninth or tenth century. One variety was collected wild in the Sudan and later cultivated in that and other parts of Egypt, and is known from its port of shipment as Alexandrian senna. The other variety is cultivated in the Tinnevelly district of India from a wild Arabian species. Although only introduced into India less than 200 years ago, over 25,000 acres are devoted to the cultivation of what is now called Tinnevelly or India senna. In the sixteenth century some was cultivated in southern France and Italy, but this has long since been discontinued.

Senna is used by physicians and is also a popular home remedy. By far the greater use of senna, however, is in the field of patent medicines, where thousands of pounds are used annually for each pound used otherwise.

Castor Oil. The small boy's bane, according to the comic papers, this medicinal oil, which dates back to our earliest historic periods, helped win the World War, for it was found to be indispensable in airplane lubrication, and in order to obtain supplies before the knowledge of its need would send prices skyrocketing, the detailing and selling organization of one of our large American drug manufacturing houses was secretly put to work, so effectively, that on a certain day excess stocks were simultaneously purchased in every part of the United States and the supply thus assured.

The plant was known to the ancient Romans as "Palma Christi," in allusion to the shape of the leaves. It is a native of India. Herodotus refers to it as "Ki Ki." The word translated "gourd" in the legend of Jonah is believed to refer to the castor oil plant, which is a much more reasonable interpretation of the occurrence therein related. Theophrastus called the seeds "Kroton," from their resemblance to the dogtick of that name. The seeds have been found in Egyptian sarcophagi. It was the seeds and not the oil which were popularly known in European medicine until the eighteenth century. The name "castor oil" was given to it in the erroneous belief that it was derived from the seeds of a West India plant named Angus Castus.

This plant is often grown for ornamental purposes and more or less successful attempts were made to cultivate it commercially

in the Southern States during the World War, but our present supplies come almost entirely from India, its original home, where, according to De Candolle, it has been cultivated for more than 4000 years or since before the time when the inhabitants of the land of Shinar built the famous tower of Babel.

The new world has given much of value to mankind, both in foodstuffs and in drugs. By far the most important of the latter is the drug from which quinine is obtained, which is cinchona.

Cinchona is the bark of a small tree originally growing on the slopes of the South American Andes. To do full justice to this drug we should have to devote an entire evening to it alone. It is possible only to point to some outstanding facts.

Contrary to the history of most drugs, we find no certain evidence that cinchona bark was ever used as a medicine by the South American natives prior to the advent of their white conquerors, and the traditions concerning it are few. Even the Peruvian native doctors of today do not employ it and the Indians themselves are antagonistic toward its use.

Peru was discovered in 1513. No mention of this wonderful bark was made for more than 100 years. In 1638 the wife of Count Chinchon, Viceroy of Peru, was cured of a stubborn intermittent fever by the use of the bark of a native tree. Its virtues were so quickly extolled that within two years it had been introduced into Spain and a few years thereafter into the rest of Europe. Being largely distributed by the members of the Society of Jesus it came to be called "Jesuits' Bark" and "Jesuits' Powder," "Powder of the Cardinal" and "Powder of the Fathers." It was also called "Polvo de Condesa (The Countess's Powder)," "Peruvian Bark," "Peruvian Powder," "Fever Bark" and similar names of obvious origin. When Linnaeus later came to classify it and name the plant, he made an error in spelling the name of the Countess of Chinchon, and it has been known as Cinchona ever since.

It was first introduced as a nostrum, advertised in the newspapers of the day as a cure for fever. It was said of its early history that "only laymen, charlatans and semiprofessional empiricists" were willing to use it. Protestants refused to employ it because of its association with the Jesuits and its name. At first it was worth almost its weight in gold, for even when used empirically in certain kinds of fevers its curative effects were marvellous. The greatest handicap to its use lay in the fact that it upset all schools of medi-

cine of that period which were based upon humors or fluxes. Some physicians preferred to die rather than use remedies so opposed to principles of the then existing practice. It was the beginning of the end of Galenism which had held undisputed sway for more than 1500 years. Many physicians of that day would not use a drug not known nor prescribed by Galen. Ralph Irving, a writer on the subject, in 1785 said of cinchona:

> "There are interwoven the story of commercial greed and the efforts of the self-sacrificing pioneer, antagonisms of religious sects and rivalries of nations, distractions bred by medical ethics and personal hatred within professional ranks."

Sydenham and Huxham, both eminent English physicians of their day threw off the shackles of prejudice and used the drug with great success. We still have in the Pharmacopœia today a preparation of cinchona bark known as Huxham's Tincture, devised in 1755. Torti, an Italian physician of recognized standing, not only introduced it into the medical practice of his country, but in connection with its use for ague coined the word "mal-aria" literally, "bad air," for that disease now known to be due to a blood parasite introduced by the sting of the mosquito, was associated with the exhalations of marshes.

Talbor, a charlatan in English medical practice, attained great fame by curing first the daughter of a peer and later Charles II, who knighted him and appointed him royal physician at 100 pounds a year. Talbor then went to Paris and cured the Dauphin, son of Louis XIV. For this service he received 2000 guineas, a pension of 100 pounds a year and the title "Chevalier." He then went to Spain, where he cured the queen (malaria seeming to be a prevalent disease of the nobility of that time), after which he returned to London and died in 1781 at the early age of forty.

The drug of this period had begun to be highly adulterated and attempts were made as early as 1743 to transport plants to Europe with the view to establishing its cultivation in other parts of the world. La Condamine made the first attempt and lost his whole cargo in a heavy sea at the mouth of the Amazon River. Other attempts were unsuccessfully made by the English and the Dutch. About the middle of the nineteenth century a traveler named Ledger obtained some seeds in Bolivia, part of which he sold to the Dutch Government for the ridiculously low price of £33,

with the agreement of a further payment if the seeds grew. In the first year the Dutch succeeded in raising 20,000 plants from this lot of seeds and paid Ledger an additional sum of £100. From this nucleus the Dutch started the cinchona plantations of Java, which now dominate the world's supply.

In 1895 Ledger was found living in poverty in New South Wales and after two years of argument the Dutch were induced to give him a beggarly annuity of £100, although the income of their plantations ran into the millions.

The Indian Government, which had also established successful plantations with seed procured from Ledger for nothing, refused in 1895 to give him anything in his evident time of need.

In 1812 Gomez, a Lisbon chemist, had prepared a concentrated preparation of the bark, which was in reality a crude form of quinine, which he called "cinchonino." In 1820, Pelletier and Caventou, the pair of French apothecaries who did so much for the plant chemistry of those early days, proved the basic properties of the active principles and separated and manufactured for use, quinine and cinchonine. In the meantime, another French chemist named Seguin, had made himself a laughing stock for all time in the scientific world by asserting that the active principle of cinchona bark was gelatin, basing his claim on the misleading fact that both gelatin and quinine are precipitated by tannin.

It remained for Perkin to add the last fantastic chapter to this individual romance, for it was his unsuccessful effort, in 1856, to prepare quinine synthetically that led to the discovery of the first coal tar color, and this unlocked the secrets of the tar barrel with its yet increasing avalanche of synthetic products.

Coca. This leaf drug must not be confused with Cacao, from the seeds of which chocolate and cocoa are prepared, nor with Coco, which yields coir, copra and the shredded delectable used in confectionery and desserts. Coca is the source of the habit-forming alkaloid cocaine. It and its products and derivatives are under the same rigid restrictions as is opium, previously discussed. Unlike cinchona, although coming from the same part of South America, its history and tradition go back to the earliest records of that proud and mighty race known as the Incas, where it played an important part in the political and religious life of that people. It is still called the "Divine Plant of the Incas."

Pizarro's invasion of Peru brought the first knowledge of this drug to the white race. It is used as a masticatory in South America as betel is used in the Orient, differing from the latter, however, in that betel has very little physiological effect, while coca is a powerful stimulant. Early commentators seemed not to have appreciated the medicinal or stimulating properties of the drug, for they speak of the curious custom of the natives of carrying a small leaf in the mouth while traveling. Even Humboldt confounded the properties of the coca leaf with the ashes usually mixed with it before chewing, evidently confusing it with clay eating customs which he had observed. Dr. Abraham Cowley in 1662 said of it in regard to its sustaining qualities as used by the natives,

> "Each leaf is fruit, and such substantial fare
> No fruit beside to rival it will dare."

The drug was introduced into Europe in 1565, and so little were its effects understood, using it simply as a drug and not in concentrated form of the active principle, cocaine (which was not discovered until late in the eighteenth century), that Joseph D'Acosta, a Jesuit missionary, described it as "a delicate and royal leaf," and Markham observed that "of all narcotics used by man coca is the least injurious and the most soothing and invigorating."

Toward the close of the eighteenth century it was the basis of a well-known nostrum prepared by a French physician named Mariani, who had a coca garden growing in connection with his establishment. So great was the success of the preparation that Pope Leo XIII sent to Mariani a gold medal as an expression of his ecclesiastic approval of it.

It is extremely probable, that had the local anæsthetic effects of cocaine, the active principle of the drug, not been discovered, the drug itself would now be an esteemed and useful article of the materia medica instead of being tabooed, as it is. The habit producing effect of cocaine and its widespread illicit use has brought discredit upon a drug which, when properly employed, was found to be very useful.

Ipecac. The root of a Brazilian vine brought to France in 1672 by a physician named LeGras, ipecac created nearly as much of a furore in its time as did cinchona. It is said that the name is derived from a native word "pigaya," and that it was first used by a Portuguese friar in the treatment of dysentery. Several accounts

exist as to the way in which a semi-quack named Helvetius learned of its properties.

One account states that an apothecary named Clanquelle kept the stock of the root which LeGras imported and that Helvetius, a friend of the apothecary, obtained his supplies in this way. Another version says that a merchant by the name of Garnier imported 150 pounds which he brought to the attention of his physician, Afforty, who paid little heed to its possibilities, but that his assistant, Helvetius, learned to use it with success. At any rate, the tale continues that LeGras gave too large doses of the drug and damaged its reputation among physicians, but that Helvetius used it as a secret remedy and made many remarkable cures of patients suffering from dysentery. His professional success being called to the attention of Louis XIV, whose son, the Dauphin, had been cured of a serious dysentery (the Dauphin seems to have been a proving ground for new world drugs), that generous monarch paid $4000 to Helvetius for the secret of the cure. The formula for the cure proved to be a complex mixture of drugs, of which only one ingredient, called by Helvetius "Radix Antidysenterica," and identified as ipecac, was proved to be effective. Helvetius was sued by Garnier, who claimed a share of the reward, but the courts decided in favor of Helvetius.

For a time ipecac was also called Brazil Root and was very scarce and shrouded in much mystery as to its origin and identity. This confusion led to a mistake by Linnaeus, the eminent Swedish botanist, who in 1764 erroneously described and named the wrong plant as the source of this drug. In our own time ipecac has had quite a vogue as a reputed remedy for pyorrhea.

Sarsaparilla. This is the root of a climbing vine of the Smilax family, growing in Mexico and Central America. It was described by Monardes and was at first called "Zarza-parilla" and later "Salsaparilla." Some people even today can neither spell nor pronounce the word but say something that sounds like "Sassafrilla."

Sarsaparilla was vaunted as a remedy for blood diseases, especially syphilis. The reputed effect was mainly due to the sudorific property of the large volumes of the infusion that were directed to be drunk and also to the presence of really active drugs such as guaiac or mezereum which were added to its compounded preparations. As a matter of fact and recorded scientific observation, sar-

saparilla has little or no real activity or virtue, and as if to add insult to injury it will probably shock a number of persons to learn that sarsaparilla has no flavor. That is to say, no pleasant flavor, for the infusion has a mawkish, sickening taste of no particular distinctiveness. What then *is* the flavor so popularly known as sarsaparilla? Sh! Let me tell you a secret. It is a mixture of our old standby flavors—wintergreen and sassafras. "Well," you say, "what about the wonderful blood purifying medicines, the 'Sarsaparillas' that blazoned forth from billboards and newspapers, to say nothing of the almanacs about thirty or forty years ago?" Another secret is about to be disclosed. Any virtue which these preparations possess is in all probability due to the potassium iodide which all of them contain and which does have what is called "alterative" effects. One early medical writer of the eighteenth century came pretty near to telling the truth when he said "Sarsaparilla is fitter for lighting fires than for use in physick."

Guaiacum. This is the wood of a West Indian tree, much employed in medicine at one time and now little used, not because of its inertness but because of its irritating qualities and because better remedies have been found for the same purpose. It was first brought from Santo Domingo, and Guayacam was its original native name.

It was used in syphilis and in rheumatic affections. The Canon of Merton Abbey, in 1536, extolled its virtues in the following manner:

> "The wood called Guaiacum that healeth the French Pockes and also helpeth the goute in the feete, the stone, the palsy, dropsy, falling evyll and other dyseases."

It was so highly thought of by some that they called it "Lignum Sanctum" or "holy wood." Many know it better by its common name of Lignum Vitæ, for it is the heavy and resinous wood used for knife handles, bowling balls, rolling pins, mortars and pestles, and other turners' ware. It is the shavings, raspings and chips, the by-products of its modern industrial uses that now supply the demand for the small amount of this drug that is still used in medicine.

Let us now go up another by-path and consider some of the unusual drugs of the past.

The Unguentum Amarum and the Sympathetic Powder of Kenelm Digby, both of the seventeenth century, were illustrations of the vicarious effect of drugs in treating wounds. In both of these products, which were recommended principally for wounds made by swords or spears, the remedies were not applied to the wound, but to the weapon which caused it, if it could be located, or failing that, a bloody garment which had been removed from the victim. The interesting feature of this treatment consisted in the fact that the wound was simply to be cleaned with water, bound up tightly with a clean piece of linen and not to be unbound for at least a week. This crude application of what we now know are principals of asepsis, together with the tendency of many such wounds to heal by first intent, as it is called, probably increased the percentage of cures by this method to a point where the absent treatment really appeared to have merit.

The mandrake of early times was the root of a plant growing abundantly in Greece and other Mediterranean countries. It is entirely distinct from the drug known by that name today, which is the underground portion of the Mayapple plant. It was believed to have magical properties, even so far back as the time of Homer. It was also called "Planta Semi-hominis" or "half-man plant," on account of the bifurcated appearance of the root. It was believed to exist in two forms—male and female. The soporific properties which are credited to this drug have made it a favorite among classical authors. Shakespeare makes Iago say:

"Not poppy, nor mandragora,
Nor all the drowsy syrups of the world,
Shall ever medicine thee to that sweet sleep
Which thou owedst yesterday."

In Genesis, the Bible says Reuben gathered mandrake and his mother Leah bribed Rachel with them to permit her to enjoy Jacob's affection, and for centuries it was used in love philters. It is only fair to say that the rendering of this term has been questioned by some Biblical authorities.

The price of the root was high because it was believed that the best variety could be collected only under the gallows of one who was legally hanged, and when dug at midnight, as was required, the collector must needs stop his ears with wax to keep him from hearing the terrible shrieks of the root as it was torn from the earth, the hearing of which might strike him dead. As an

additional precaution against hearing the collector often blew a horn.

In "Romeo and Juliet" Shakespeare alludes to this:

> "And shrieks like mandrakes torn out of the earth,
> That living mortals hearing them run mad."

Pliny speaks of the dangers associated with the collection of this drug and says: "Whoever would dig it must avoid having the wind against him and when he digs should face in the direction of the setting sun."

The soporific effect is also referred to by Cleopatra, when desiring to sleep away the time during Antony's absence, she says: "Give me to drink mandragora."

COLLECTING MANDRAKES, FIFTEENTH CENTURY.

Peters' Pictorial History of Pharmacy. G. P. Englehardt & Co.

It is related of Hannibal that fighting a large army of African rebels, he simulated retreat, but left on the battlefield a large number of vases of wine in which mandragora had been infused. The savages having drunk the wine, were stupefied and fell an easy prey to Hannibal's troops upon their return at the proper time. It is strange, indeed, that a drug whose properties were so circumstantially described by ancient writers as possessing such marvelous soporific effects should have so little real value that in our own time it is not even recognized in the pharmacopœias of European

countries where the plant still grows. It makes us wonder how much of the ancient writings is worthy of credence.

The animal drugs of former medical practice were for the most part so revolting in character that a frank discussion of them is inadvisable. Their general character was referred to by the eminent satirist, Dean Swift, in "Gulliver's Travels," where in describing his experiences among the Houynhmns, he speaks of medicines from "herbs, minerals, gums, oils, shells, salts, juices, seaweed, excrements, serpents, toads, frogs, spiders, dead men's flesh and bones, birds, beasts and fishes."

The early London Pharmacopœia included more than two hundred separate substances of animal origin, most of them exceedingly disagreeable in character. Mummy, or dried human flesh, originally obtained from the Egyptian sarcophagi, was later permitted of domestic origin, the requirement being that the flesh should be that of a young, red-haired man who had died a violent death. Human fat was used until nearly the end of the eighteenth century, and was sold as low as fifty cents an ounce. One authority complained that the business of the apothecaries was seriously hampered "as everybody knows in Paris the Publick Executioner sells it to those that want it, so that the Druggists and Apothecaries sell very little of it, although they vend a sort that is prepared with aromatical herbs, and which is without comparison much better than that which comes from the hands of the Hangman."

Even in Pepy's time live pigeons were cut in half and applied to the feet of patients suffering from the gout, the Queen of Charles II being one of the notable cases thus treated. Snails for cough syrups and earthworms for lung complaints were among the least objectionable of internal remedies. Lice and bugs were also esteemed greatly. It has remained for a comparatively modern work, however, to furnish the most amusing incident in connection with animal drugs of this character. Homœopathic pharmacopœias, as late as forty years ago, carried a list of many animal drugs of unpleasant character. In an edition of *The American Homœopathic Pharmacopœia of 1895* it is stated, under Cimex Lectularius (the entomologic name for bedbugs), "This insect is too well known to require a description." This I consider a gratuitous insult to every homœopathic physician and pharmacist.

Bezoar stones were among the more curious animal remedies. The bezoar is a semi-mineral concretion found in the intestinal tract

of herbivorous animals. The better sorts of bezoar came from the Persian wild goat. There was an Oriental bezoar of the above origin and an Occidental bezoar from local animals. These bezoar stones, as they were frequently called, were often counterfeited, and upon one occasion the Lord Mayor of London called upon the courts to conduct an investigation as to the character of certain questionable bezoar stones. A genuine stone of about four ounces weight was known to have brought over $300. Admiral Lancaster, the commander of one of the early British spice squadrons brought, as a gift for Queen Elizabeth from one of the Oriental potentates, a genuine bezoar of great value, which Elizabeth never used as she died before Lancaster arrived.

Vipers' flesh and vipers' fat were also of importance as being one of the indispensable ingredients in genuine Theriaca, and wine of vipers was a popular tonic.

The unicorn was still authoritatively described by so-called naturalists and drug authorities in the eighteenth century. The horn was the portion employed. Later investigators discovered that what was sold for and believed to be the horn of the unicorn was in reality the horn of the narwhal, a mammal of the northern seas.

The phoenix and the dragon were also referred to confidently by early medical authors as sources of remedial power. The drug known as "dragon's blood" is still used under that name in the East, but it is a bright red-colored resin and is now used in violin varnish.

Contrast these numerous and disgusting crude animal products with the few drugs of animal origin today, numbering less than a score and including lard, woolfat, suet, beeswax, cochineal, cantharides, gelatin, oxgall, cod liver oil, egg, milk, beef extract, the enzymes, pepsin, rennin and pancreatin, and a few glandular products. The animal drug therapy of today is largely concerned with the vaccines and sera, the products of a scientific development of biological chemistry, as far removed from the crude empiricism of the past as it is possible to imagine.

Probably the only animal drug of real interest and also of value that has come down to us, not only unimpaired but even strengthened in reputation by the researches of science, is cod liver oil. The empiric use of this product, crude though it was in olden times, set it apart from other animal oils as of peculiar value in what are commonly called the wasting diseases. As time went on

and science attempted to explain the cause of this difference from other oils, first one and then another reason was given. Compounds of iodine and bromine were at first believed to be present in appreciable amounts. When this was proved not to be the case, the search began for basic active principles and the so-called alkaloids or concentrated products derived from the oil made their appearance. These were found to be mainly decomposition products resembling ptomaines, present in amounts varying inversely with the purity of the oil, and still the pure oil held its vogue because it produced therapeutic results.

PREPARATION OF COD LIVER OIL IN EIGHTEENTH CENTURY.

From Peters' Pictorial History of Pharmacy. G. P. Englehardt & Co.

Within the past five years the real reason for its curative power has been found in its high content of vitamines, those potent food accessory substances discovered within the present generation.

And now, what of the end of our tale? What have we learned from our quest? How can we best profit by it? One impression stands out conspicuously. Very little of the knowledge of the past was accurate. Can we be certain that we are right today or are we bound by the wheel of fate to go on as each generation has done before, correcting the errors of its predecessors and leaving other errors equally inexcusable for its successors? Out of the past comes news of strange doings, light from flickering torches, truth dis-

torted by those who cannot distinguish it from error, and strength —strength to carry on in spite of handicaps and discouragements, looking toward the time when each shall see things as they exist and not as he imagines them.

News from the past.
The mysterious Orient sends its silent message
Through divers channels learned by modern man;
Of scourging hordes, of kingdoms overthrown,
Of birth, of love, of death, of strife, of peace;
The steles of stone and bricks of ancient clay
Transmit the message of the mighty years.
News from the past.

Light from the past.
What occult force is that which lights the darkness
Of this the present? Down from mystic times
Whose beam is so diffused that few can tell
Where shadow ends and light begins, we search,
Groping, with hands untrained as yet, to find
That which we seek, yet knowing not its name.
Light from the past.

Truth from the past.
The question still unsolved, yet solved anew
By each succeeding age is—What is Truth?
We learn the answer now, but when tomorrow comes
We find we know it not. What force
Thus blocks our quest and takes the prize away
When we are near the goal. 'Tis God's almighty hand.
Truth from the past.

Strength from the past.
That first dynamic force which urged the cell
Primordial to function, and beget its kind and live,
Still urges us; though centuries elapse
Our strength is yet unspent. Whence comes this flood
Of power strong and sweet? When rightly used
It brings us close to Him who gave it first.
Strength from the past.

THE STORY OF RUBBER.

By J. W. Sturmer,

Dean of Science, Philadelphia College of Pharmacy and Science.

How old is the New World? How long have the warm, dark jungles of the valley of the Amazon provided a congenial home for amphibians, insects, and the rubber trees? We do not know. Science offers only conjectures. When did the Red Men appear, and when did they learn to milk the "weeping tree," and to appropriate to their use its sticky, milk-white juice? History fails to enlighten us on this point, and again we must acknowledge, we do not know.

We know only that a certain daring Genoese sea-faring man, who, sailing under the flag of Spain, and in search of a westward passage to the spice lands of India, discovered America, and the Red Men—and rubber. He never knew that he had visited a new continent, nor did he realize that the sticky juice which exuded from certain trees felled by his crew was destined to become a commodity of great importance. And when a few years later bouncing balls made from this milk juice were brought to Spain, these were thought of only as a new kind of toy for children. It appears the world, in Columbus' time, was not ready for this great gift of nature, and more than two and a half centuries elapsed before it was seriously investigated with a view to its utilization.

It was Joseph Priestly, then in England, who noticed that it would erase lead pencil marks, an observation which suggested the term "rubber," a name which has endured to this day. The great Michael Faraday subjected rubber to ultimate analysis; but his findings led to nothing of practical importance.

As has been intimated, not the scientists of Europe, but the Indians of South America were the pioneers in discovering use for this jungle product. They employed the milk juice to waterproof their garments; and by drying the juice in a smoky flame, and upon clay molds, they fashioned useful articles, such as bottles, powder flasks, and tobacco pouches. They succeeded also in making waterproof shoes, which in course of time entered commerce in quantity and found ready sale. About a century ago a pair of such "gum shoes" was brought to New England, and within a few years a brisk trade at $5 a pair had been established for this type of footwear, despite their susceptibility to temperature changes, which was most pronounced, for in cold weather they became hard and brittle,

and on warning, as sticky as modern chewing gum, as is the nature of crude rubber or caoutchouc.

A Scotchman by the name of Mackintosh, in 1823, improved upon the waterproofed garment of the Indians by impregnating textile fabric with a solution of crude rubber in a solvent which was virtually impure benzene, and thus was invented the raincoat which to this day is known as a mackintosh.

To be sure, these raincoats, as well as all other crude rubber products, exhibited the same objectionable qualities noted in the South American gum shoes—they hardened in the cold, and got sticky on warming. The stuff was most exasperating, and many attempts were made, both in Europe and in our own country, to overcome the difficulty.

The Problem Is Solved.

One of the early experimenters with rubber was Charles Goodyear. He had been a hardware merchant in Philadelphia, and by chance became interested in life preservers, which in turn drew his attention to the problem of making rubber resistive to temperature changes. He tried nitric acid, but without success. He then purchased a formula involving the incorporation of sulphur and white lead as stiffening agents. As the story goes, he quite naturally resorted to heat as an aid in the mixing, and on one occasion some of the mixture was spilled on the stove, and was accidentally subjected to more prolonged heating than had been intended. Fortunately, Goodyear was an observing experimenter. He noted that the mass which had been exposed to continued heating had acquired new characteristics. This clue he followed with patience and intelligence, finally succeeding in making a product which exhibited remarkable elasticity, and which was not made brittle by cold, or sticky by heat. He had evolved a new substance, a man-made product, superior to the crude rubber of the jungle. The magic wand of Vulcan had under Goodyear's guidance touched and transformed the mixture, and had created a material of boundless possibilities, which was destined to become as indispensable as steel. *Vulcanizing,* the fundamental process of rubber manufacture, had been invented. It was an epoch-making invention.

Goodyear appreciated the commercial value of his discovery, and about 1839 took out his first patent. A few years later he estab-

lished in Springfield, Massachusetts, the first factory for the production of vulcanized rubber. Thus was born a new industry which has since assumed billion-dollar proportions, providing literally thousands of articles which have become necessities of modern life. Charles Goodyear and his brother made numerous supplementary discoveries, including a process for the making of hard rubber or ebonite, and was granted as many as sixty patents. The litigation incident to the defense of these patents involved the legal experts of his day, including Daniel Webster and Rufus Choate. Also, they absorbed all of Goodyear's earnings, and he died, as Columbus had died. poor and disappointed. The one had discovered the land of rubber; the other had given us the rubber we can use. Neither gained riches. But the names of both deserve to be linked in connection with the development of a great industry, which has brought affluence to thousands, and has contributed conspicuously to the creature comforts of man, to scientific advancement and to industrial progress.

The Rubber Country.

When Goodyear's new project was gathering momentum, Nathaniel Hawthorne was Surveyor of Customs at Salem, which at that time was a busy seaport. In the old records of its customhouse, one may find in Hawthorne's handwriting various entries covering cargoes of crude rubber. No doubt the sea captains returning from Brazilian ports spun many a strange tale of adventure of rubber gatherers in the South American jungle. Out of these Hawthorne could have built literary masterpieces. He was, however, at that time engrossed in the depicting of New England life, and had no time for "South American Tales—Twice Told." But there is no dearth of literature about the rubber country, nor about rubber gathering, for the explorations in the Amazon valley have, until quite recently, been largely in the interest of rubber. Indeed, in the Amazon region, rubber gatherers are the pioneers, just as the trappers are in the Canadian wilds.

When Theodore Roosevelt in 1914 emerged from the uninhabited stretches watered by the River of Doubt, he encountered, as the outposts of civilization, the camps of the rubber gatherers. A few years before Roosevelt's explorations Algot Lange had accompanied an expedition of rubber prospectors to the head waters of the Amazon, and this writer has given us a most vivid account of the great

tropical jungles, peopled only by unclothed savages of cannibalistic habits, and skilled in the use of arrow poison, and in the handling of the deadly blow-gun. He paints the jungle as a most inhospitable region, flooded during the rainy season by the overflowing rivers, whose recorded rise reaches fifty feet or more; a valley which, after the flood-waters recede, quickly greens out with dense and tangled vegetation, through which the traveler must hew his path with a

Poling Down to Navigable Water.

machete—a humid, hot wilderness, where snakes lurk, parrots and parrakeets screech, owls hoot, monkeys chatter, jaguars stalk their prey, and where insect pests abound and make human life a burden. It is a land of tropical fever and of beri-beri, diseases which annually take their awful toll of human lives, because this region is the habitat of the wild rubber trees, and because rubber for many years has meant much gold.

The fact that the rubber trees of South America are indigenous to low-lying country, flooded annually, gives us the reason for many

things which seem strange. It explains why no railroads have been built to tap the wealth of the jungle, why no wagon trails have been blazed through the wilderness, why the outposts of the rubber industry are on the watercourses, why the huts of the gatherers are built on stilts, and why rubber collecting is not a continuous operation, but a matter of annual expeditions. It helps us to more fully appreciate the accounts of explorers. We can understand and give credence to their descriptions: the dankness, the oppressive, humid atmosphere, the prevalence of diseases. We can realize the hazards and hardships of the men who each year steam, then paddle, then pole, for thousands of miles upstream, in order that, nearly a year later, they may lay their contribution of the world's rubber supply upon the wharves of Manaos, or of Pará, whence ships may carry it to European or to North American ports.

Rubber Plantations.

It explains also why rubber plantations came to be, and why these now furnish the major portion of the world's supply of rubber. For the well-nigh insuperable obstacles which nature has put in the path of the gatherer of wild rubber, and the resulting uncertainty of the supply, suggested the plan of transplanting rubber trees to a more salubrious and more accessible region. So about the time of the Philadelphia centennial, an Englishman, Wyckham by name, procured a liberal quantity of the seeds of the most important of the rubber trees of Brazil, namely, of the Hevea braziliensis, and shipped his precious cargo to England, for planting in Kew Gardens. When the seedlings had grown to proper size, they were transplanted to Ceylon, a British possession, and were nurtured, pruned, and coddled, just as is done in our country in a nursery with a choice strain of apple trees. And from this, the first rubber plantation, seedlings were procured for extensive plantings by British and Dutch companies, on the various islands which straddle the equator below the Malay Peninsula, where the climatic conditions have proved favorable, so that at the present time these plantations have grown to cover more than three and one-half million acres, and have come to furnish 92 per cent. of the rubber supply of the world. For it is now cheaper to *grow* rubber than to gather the wild product in the wilderness.

Rubber-Producing Plants.

While plantation rubber is obtained almost wholly from one distinct tree, the Hevea braziliensis, wild rubber is of divers sources. The wild rubber known in the channels of trade by the Spanish name of Caucho, a softer and less valuable product, is obtained from a tree known as Castilloa Ulei, which is indigenous to the Amazon region. In the Brazilian state of Ceará several species of Manihot are exploited for the so-called Ceará rubber. African rubber, a sticky, ill-smelling mess, is obtained principally from giant creepers of the genus Landolphia. It is full of impurities and low in elasticity, yet suitable for certain purposes in rubber manufacture. The chief source of the rubber from Assam, in Asia, is the well-known Ficus elastica, cultivated in this country as a house or porch plant. The Mexican rubber, called guayule, is obtained from a shrub,—and so on, at great length. Indeed, about a thousand distinct plants are known to possess a rubber-containing milk juice, and some of these are herbaceous and grow in our own country. There is, for example, the milkweed, with which a well-known automobile firm has recently experimented; and it may be that eventually we shall be able to grow our own rubber, just as we now grow our own long-staple cotton, which is the other important commodity for the manufacture of automobile tires.

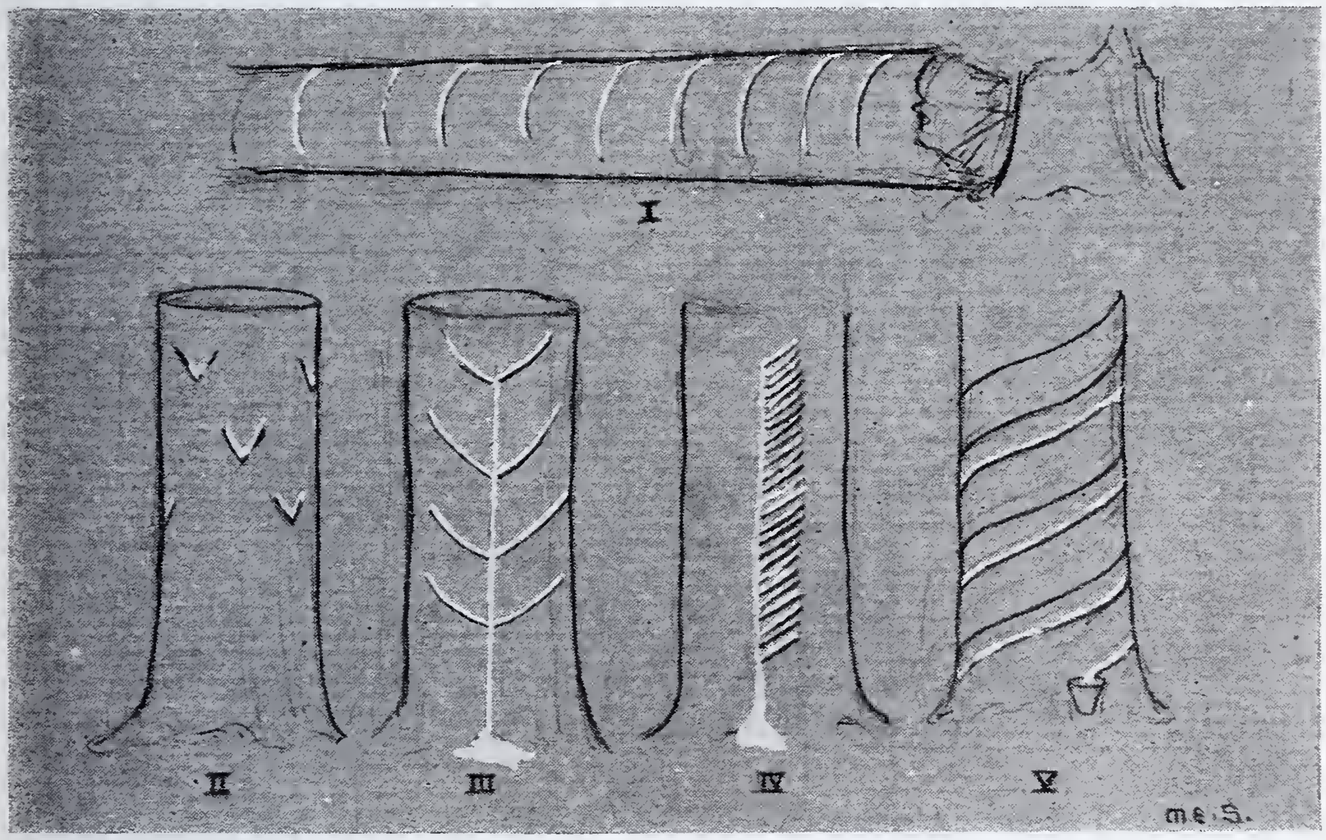
But at the present time the world's supply of rubber is grown on a comparatively narrow strip—within about 200 miles north and south of the equator—the rubber belt which encircles the earth about its middle. The rubber from the original rubber country enters commerce from the seaport of Pará, on the mouth of the Amazon, or from Manaos, a city located about 1200 miles upstream. But the commercial designation Pará rubber refers at the present time to the product of the wild Hevea braziliensis, no matter where collected, or from which port it has been shipped. It is used also in a more general way for any kind of hard crude rubber of good quality. The plantation rubber, though from the same botanical source, is not precisely identical with wild Pará, of which, it may be mentioned, there are several grades; but the difference was more pronounced some years ago than at present.

Tapping the Rubber Tree.

The tapping of the rubber tree is done variously. There are as many methods as there are ways of skinning a cat. The South

American tapper cuts a V with a hatchet-like tool, and collects the milk-juice or latex in a small cup of tin or of clay at the point of the V.

In some localities the herring-bone incisions are in vogue. But on the rubber plantations tapping has been reduced to an art. A small, razor-sharp knife is employed, and only about one-twentieth of an inch of bark is removed at each cutting along a diagonally-cut



Various Ways of Incising the Bark.

channel. The gatherer of wild rubber taps from seventy-five to one hundred trees a day, following the paths which he has previously cut through the jungle, and which constitute a number of loops radiating from a watercourse, or from a path to the camp. On the plantations, however, where trees grow in orderly rows, about 110 to the acre, 400 or more trees are visited by a single gatherer. The latex, or milk-juice, is not the sap of the tree, but courses through tubes in the inner bark, running mainly up and down, but connected, one with the other, like canals in Holland. Great care must be observed lest the cut enter the wood, which would lead to contamination of the latex with sap, and would cause injury to the tree.

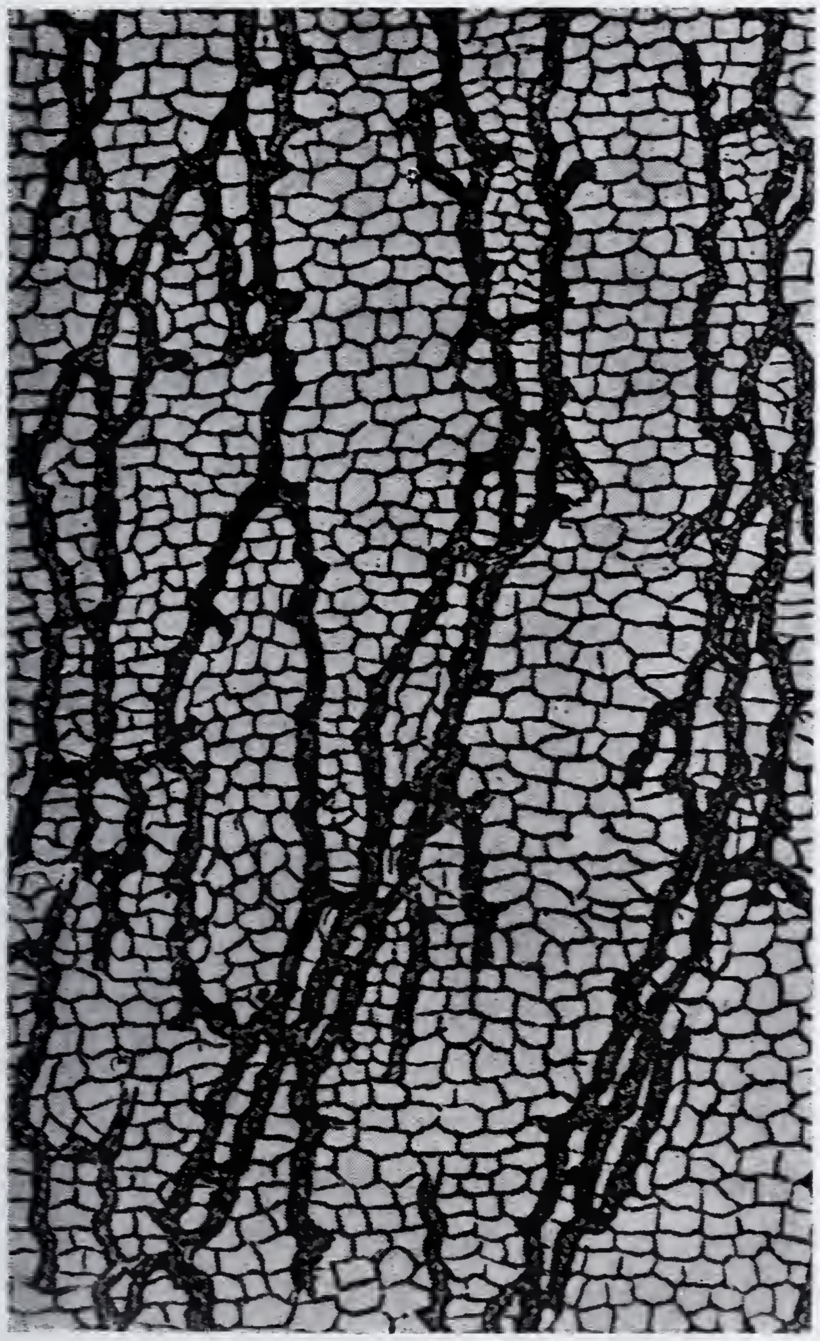
The Latex.

The latex which exudes is milk-white, or nearly so, and on exposure to air coagulates, just as does blood from a cut, plugs the

In Tapping Wild Rubber Trees, the Main Object Frequently is to Get All the Tree Will Yield.

wound, and prevents bacterial or mold infections. Moreover, any insect attempting to enter the wound would come to grief. It appears, therefore, to the biologist that the latex serves an important

purpose in the struggle for existence to which the rubber tree is subjected in its natural habitat, where the humidity and temperature are high, and the conditions are favorable to the growth of micro-organisms.



Latex Tubes in a Milk-Juice Yielding Plant.

The latex is an emulsion-like suspension resembling cream in general appearance. Under the microscope it shows particles from .0006 inch to .003 inch in diameter, dispersed through a watery fluid, exactly like the butter-fat is suspended in milk or cream. Hence the term *latex,* from lac, which is Latin for milk.

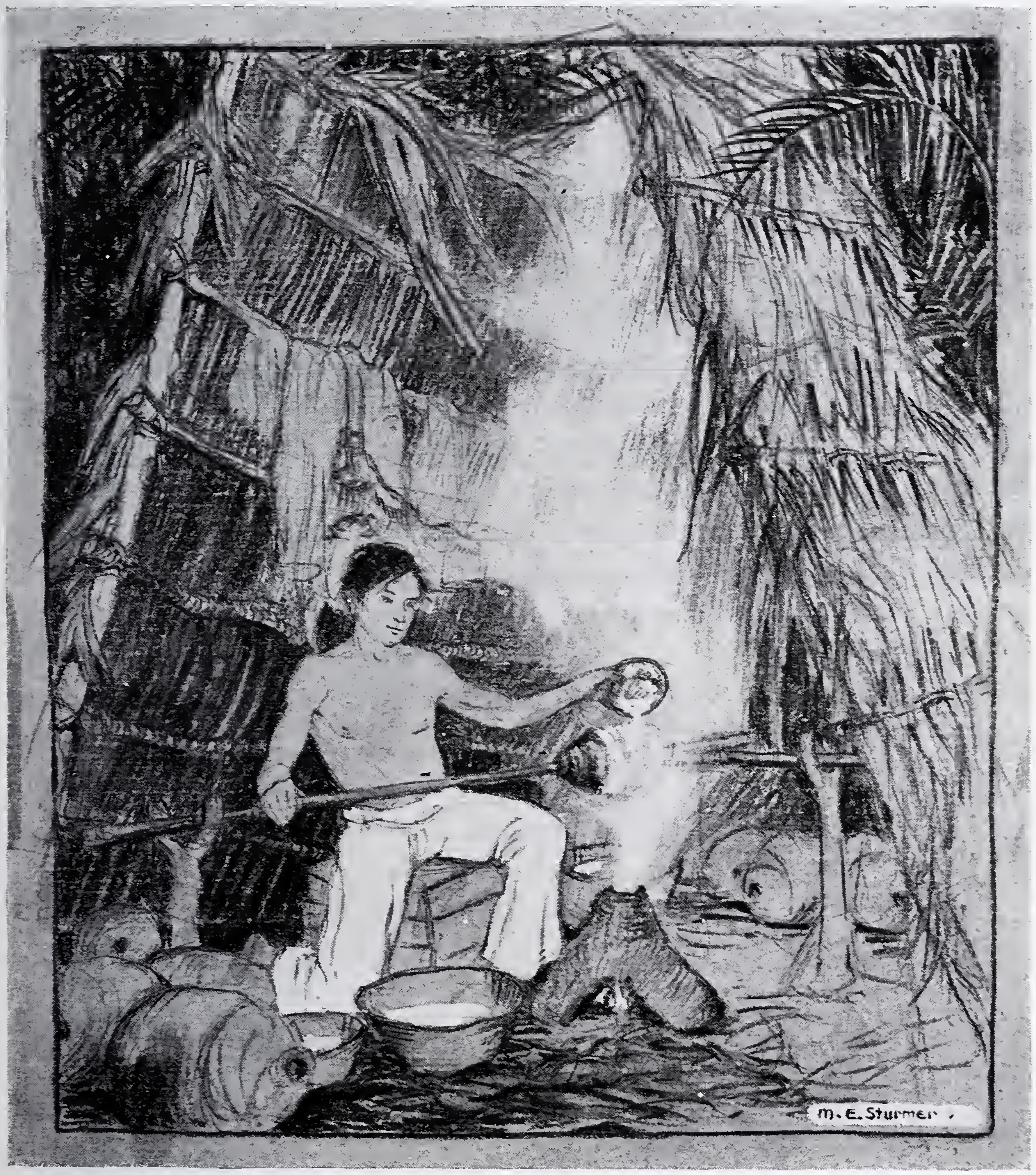
About one-third of the latex is rubber. There is present also about 1.65 per cent. of resinous matter. And in the aqueous liquid, in which the rubber and the resin globules are suspended, there is found in solution about 2 per cent. of protein, and about 7 per cent.

of mineral matter. When the tree has been tapped, the latex flows for about an hour, the average yield being approximately an ounce, though it varies naturally, with the size and age of the tree. The tree in the jungle is usually tapped daily; on the plantations, however, it has been found advantageous to tap on alternating days, or on the third day. The planters obtain an annual yield per tree of about three pounds of raw rubber, or about 350 pounds per acre. This means that on an average, two trees bleed for an entire season to provide the rubber for one Ford tire. But as there are about three and a half million acres in rubber plantations, with about 110 trees to the acre, to say nothing of the wild rubber from South and Central America, it appears that for the present there is no danger of a dearth of this modern necessity.

Coagulation.

If rubber latex is allowed to stand, it undergoes spoiling, just as does cow's milk. It thickens, becomes discolored, and gives off an offensive odor, due to the putrefaction of the nitrogenous matter. It is important, therefore, that it be coagulated as promptly as possible. The South American native accomplishes this result by drying the latex over a smoky flame. His routine is as follows: In the early morning he makes the rounds along his paths through the jungle, notching the trees, and attaching the little cups to catch the exudate. Some hours later he makes a second trip, emptying the milk-juice out of the cups into a bucket. When he has returned to camp, with the product of probably seventy-five to one hundred trees, and his fellow-workers have brought in their supply, a fire is built, and is fed with wood and palm nuts until it produces a dense, acrid smoke. A cone of burnt clay is placed over the fire to concentrate and direct the smoke. A paddle is now heated, dipped into the latex, and held into the smoke until the latex has hardened on the paddle. The operation is repeated again and again, until there has been built up on the paddle, layer by layer, a mass weighing from forty to seventy pounds. The smoked and hardened latex is proof against spoiling, is, in fact, raw rubber. The heat evaporates most of the water and causes also certain chemical changes, in which effect it is aided by the acetic acid in the smoke, while the phenolic constituents of the latter play their part in the preservation. The rubber, darkened more or less by chemical alteration of certain constituents

of the latex, and to some degree also by soot, smells like a smoked ham, and is ready for shipment. It is the Up-river Pará rubber of commerce.



Smoking Latex.

But there are many other methods of coagulation. In some localities the latex is allowed to run down the tree and to solidify. It is then pulled off in form of threads and compressed into balls. The latex from species of Castilloa is coagulated by means of the juice of a plant, namely, of Ipomœa bona-nox. The product is the raw rubber known as caucho. Alum, tannin, soap, lye, certain acids,

and also salt are similarly employed. It appears that any substance capable of coagulating albuminous matter will serve the purpose, for it will alter the protein in the latex which acts as a protective colloid surrounding the rubber globules in the emulsion-like liquid. On the rubber plantations, where the process of coagulation has been subjected to scientific study, a weak solution of acetic acid is the coagulant in general use. The latex is poured into a large tank, or into stone jars, and the diluted acetic is added, together with some solution of sodium bisulphite, to prevent the production of a purple coloring matter, which may form in the latex because of certain enzyme action, and which would discolor the raw rubber. The coagulum forms gradually, and when the process has progressed to the right point, the resulting mass is passed through a masticating machine, and then between rollers to press out the excess of water. Next it is washed in clean water, again passed between rollers, and the resulting sheets are hung up to dry. By this procedure is made the "pale crepe" of commerce. Or the sodium bisulphite may be omitted, the washing in fresh water also, and the sheets, as they are received from the rollers, hung up in a large smokehouse and very carefully subjected to the smoking process. "Smoked sheets," which is the commercial name for this type of raw rubber, are usually ribbed, a result effected by using rollers with corrugations. As is well known, raw rubber sheets adhere, and the ribbed surfaces are produced to reduce this adhesion to a minimum, so that the sheets may readily be pulled apart.

But a recent development in the rubber industry eliminates the coagulation process entirely, and the fresh latex, preserved by means of ammonia water, is now being shipped direct from the plantations to the factory, where it is reduced to a solid by dropping it in a thin stream upon a rapidly revolving disc, an operation which is conducted in a heated room. By this means the latex is converted into a fine spray, from which the water evaporates, the rubber being obtained in the form of minute solid particles. As compounding ingredients, in the form of suspensions, may be poured upon the revolving disc and be atomized at the same time, an intimate mixture of such substances and raw rubber is readily obtained, and the laborious task of softening the dry raw rubber by kneading it between hot rollers, and working in the compounding agents in form of powder, is thus made unnecessary, and the danger of imperfect mixing is avoided.

Raw rubber, whether from the wilds of South or Central America, or of Africa, or from the plantations, whether obtained by one coagulation process or another, whether the product of the Hevea, or a Castilloa, or of Ficus elastica, or of the giant vines and creepers in the region of the Congo, is but raw material for the manufacturer. And when, in this country, we speak of the rubber industry we do not refer to rubber tree culture, or to collecting, or coagulating, but to the production of articles into which raw rubber enters. Of these there are many thousands. In some, as in rubber bands, elasticity is the quality particularly desired. In others, the impenetrability of rubber to liquids or to gases is the reason for its use. In electrical appliances rubber serves as a dielectric or non-conductor. The resiliency of rubber and its resistance to abrasion are valuable properties. Crude rubber, however, varies in chemical composition, and consequently also in its properties. Accordingly the manufacture of goods made of rubber involves many problems. But the fundamental problems were solved by Goodyear, though his process has in recent years undergone marked improvement, the result of scientific investigation, and of patient experimentation, conducted in a more or less empiric manner.

A Bit of Chemistry.

But what, chemically speaking, is raw rubber? We find that it is essentially a hydrocarbon, a compound of carbon and of hydrogen, with the ratio of five atoms of the former to eight of the latter—the same elements, and the same proportions, which we find also in certain constituents of volatile oils. The molecule is unsaturated, and can additively combine with sulphur, or chlorine, and with certain other elements. The chemical formula C_5H_8 does not, however, indicate the size of the molecule, which is still undetermined. Hence, the formula for the rubber hydrocarbon is usually written $(C_5H_8)n$, in which case n stands for the undetermined number.

It is not known how many C_5H_8 groups are linked together in the rubber hydrocarbon, for the methods generally employed to determine the relative weight of molecules are not applicable in this case, as the substance cannot be vaporized and cannot be dissolved to a true solution. Stating the case in chemical terms, we know the rubber hydrocarbon to be a "polymer" of C_5H_8, but we do not know the degree to which polymerization has progressed. There is

evidence, furthermore, pointing to a difference in the degree of polymerization in the different types of raw rubber. It is generally believed, also, that heat operates to de-polymerize—to form a lower polymer—while the chemical action incident to vulcanization tends to enhance it. When we consider now that the resins, the proteins, and other substances which are associated with the rubber hydrocarbon in the crude product vary in kind and in quantity, we get an inkling of the complexity of the problems which confront the rubber chemist.

There has been accumulated, however, a great wealth of facts about rubber—some chemical, others physical—and as a consequence much of the empiricism of rubber manufacture has given way to scientific procedure, and the products have been improved marvelously.

Let us return now to the epoch-making discovery of Goodyear—to the process of vulcanization. The rubber hydrocarbon being unsaturated, actually takes up and combines chemically with sulphur, and without the displacement of any of its hydrogen. A solid, of the general composition $(C_5H_8S)n$, is actually known, and no doubt constitutes a considerable portion of hard rubber or ebonite. But some of the sulphur in commercial rubber products is always present in the free state, and may be extracted by acetone or other suitable solvents, this being true for soft rubber, in which the sulphur used in the vulcanization is low in quantity, as well as for ebonite, in the manufacture of which a large amount of sulphur is employed. Indeed, the miscroscope discloses sulphur crystals in the vulcanized rubber, and many commercial rubber products are actually covered with a "bloom" which consists of sulphur. [The bloom must not be confused with the dusting powder which is talc, and which serves to prevent adhesion of rubber surfaces.]

What has been said of raw rubber may be repeated in connection with the vulcanized material, namely that many problems remain unsolved. True, much has been learned since Goodyear's day, and the process is now subject to scientific control; but when it comes to the chemical explanations of the results obtained, there is a marked diversity of conclusions. To what extent is the change in physical properties due to the formation of the sulphur compound? Does adsorption of sulphur play a part? And to what degree is the transformation due to the production of higher polymers of the hydrocarbon? Investigators are working on these problems and upon related ones.

Accelerators.

When sulphur and raw rubber are mixed, and the mixture kept, the changes due to vulcanization take place, though so slowly as to be practically unnoticeable. Heating speeds up the process. So does the presence of certain other substances, which are presumed to act catalytically. The impurities in raw rubber, the proteins particularly, appear to act in this manner. But the quantity present in crude rubber is small, and in the different kinds of crude rubber is quite variable. Hence it has become the custom to add catalytic agents, usually nitrogen compounds capable of acting as sulphur-carriers, that is, compounds which readily take on sulphur, and readily lose it, particularly in the presence of substances which have developed an avidity for this element. In the rubber industry such compounds which serve to speed up vulcanization are called accelerators. Of these the list is large. But only a small number have stood the test of practical procedure. Some are too expensive. Some volatilize at too low a temperature, their vapor causing the rubber to rise like dough, and to become spongy. Others are too poisonous. But certain compounds of aniline such as thiocarbanilid, or hexamethylene tetramine, or aniline itself, are used in great quantity, and it is a safe statement that all American manufacturers now use organic accelerators. It has been observed, also, that certain accelerators work best in the presence of certain mineral substances, which serve to accelerate the accelerator. Zinc oxide, calcium oxide, magnesium oxide, and in some cases lead oxide, are employed in this capacity. The advent of accelerators has cut in half the time of vulcanization, reduced manufacturing costs, and has doubled the mechanical strength of soft rubber. It is one of the reasons why our tires now run longer.

The Effect of Vulcanization.

Goodyear observed that his new product was not softened and made tacky by heat, and brittle by cold, and that its elasticity had been increased. But vulcanized rubber differs from raw rubber also in its behavior towards solvents. The higher the degree of vulcanization, the more marked is this difference, and solutions of rubber in carbon disulphide, benzene, gasoline, etc. are made with raw rubber. The first step is a swelling of the rubber, which is accounted for by assuming a sort of honeycomb structure of the solid. The

solvent fills the cavities and distends them, giving rise to the gel formation. The time factor is important, and different raw rubbers, as well as partially vulcanized products, differ in the time required for maximum distention. When this has been effected, shaking breaks up the gel, and disperses it through the excess of the solvent, producing a colloidal solution. Masticated or milled rubber forms such a solution more readily than the natural substance. It should be remembered in this connection that rubber solvents do swell and deteriorate soft rubber goods, such as tire treads and tubing. Rubber products should be protected against such solvents and also against oils, which have a softening effect.

The process of vulcanization is gradual, progressing by imperceptible stages. The result is a matter of amount of sulphur used, temperature, accelerators, and the duration. In practice the procedure is continued to the point where the product has acquired the physical properties desired, particularly the property of stretching to a high degree and of resistance to breaking when it is being stretched. The testing machine used pulls a piece of the rubber—a piece of certain standard dimensions—recording the elongation, and the pounds of "pull" exerted. As the piece of rubber lengthens, it resists further lengthening more and more, and more power is required. Finally the rubber breaks, and the pull necessary to accomplish this gives us the "breaking point." It is by physical tests such as these rather than by chemical analysis that the manufacturer scientifically controls the vulcanization. But the chemist plays an important role notwithstanding.

Rubber Compounding.

A tire tread made to contain nothing besides rubber and the proper amount of sulphur would, upon vulcanization to the point of maximum stretch, be too soft, and would not be sufficiently resistive to abrasion. To make the finished product of adequate firmness it is necessary to incorporate solid material which has a reinforcing effect. Of such substances, of which a great variety are in use, carbon black and zinc oxide are among the best, in part because of their extreme fineness of subdivision, the average size of a particle of carbon black being but a tenth of a micron in diameter, and that of zinc oxide of proper quality about one micron, that is to say, about 1/25,000 of an inch. Extraordinary vitality has been imparted to tires and to other rubber products by the judicious use of

mineral re-enforcing materials, which are selected with reference not alone to their fineness of subdivision, but also to their thermal conductivity, their opacity (retarding "sun-crack"), their color, their specific gravity, their inertness chemically, their cost, etc. Fine clays, lithopone, whiting, diatomaceous earth, barium sulphate, are used in great quantities.

There is also a long list of pigments and dyes in the stockroom of the rubber manufacturer, the pigments serving in some cases in the capacity of reinforcing agents or as mere fillers. Ferric oxide, lead sulphide, prussian blue, ultramarine, golden sulphide of antimony, chrome green, the ochres, are popular pigments. And as to dyes, these are synthetic compounds, popularly known as coal-tar dyes, and must, naturally, be oil-soluble, and not water-soluble. Toy balloons, and other playthings of rubber, druggists' rubber articles, and even footwear and clothing, are dyed, or are tinted with pigments. We have then in a rubber mixture, ready for vulcanizing, rubber, sulphur, an accelerator, a mineral substance to accelerate the accelerator, re-enforcing material—or only filler, where strength is not a primary consideration—and possibly pigments or dyes. What else may there be? Let us see.

Reclaimed Rubber.

Why does the junk man buy old tires, old rubbers, old garden hose? This junk goes to the reclaiming factory, where it is worked up into a product known as *reclaimed rubber,* millions of pounds of which are used annually. Indeed, about one-fifth of the rubber consumed in our factories is reclaimed rubber, though, to be sure, its use is limited to the production of certain types of rubber products, as, for example, shoe heels and soles. While its cost is far below that of crude rubber, its popularity is not primarily dependent upon this fact, for it possesses certain desirable qualities, works up easily on the mixing rollers, and facilitates the incorporation of mineral fillers and re-enforcing agents. It serves a purpose, and is not a mere cheapening agent.

The first industrial process for reclaiming rubber was invented by Chapman Mitchell, of Philadelphia, a brother of Dr. S. Weir Mitchell. It consisted essentially in hydrolysing the cotton of the rubber waste by means of sulphuric acid. But at present the alkali process, patented by Marks, is in general use, for the acid failed to

remove the uncombined sulphur, while the sodium hydroxide solution, at the high temperature employed—about 350 degrees F.—combines with this element, and makes it water-soluble.

Softening Ingredients.

As has been stated, crude rubber, on being worked between rollers, softens and develops tackiness. To what extent this change is caused by the rupture of the coating of protective colloid—the protein of the latex—and to what extent it is due to de-polymerization of the rubber hydrocarbon by the heat engendered during the manipulation, one cannot say. Anyway, this plastic condition must be achieved in order that the mineral compounding agents may be incorporated. As Pará rubber, plantation crêpe or sheets are plasticized with difficulty, not only soft natural rubbers, like the African product, and reclaimed rubber, may be employed in the formula, but also certain asphaltic residues of western petroleum (sometimes called mineral rubber), coal tar or pitch, pine tar, paraffinic, petrolatum-like materials, and fatty oils of vegetable origin, serve a definite purpose in making the "mix" for certain types of rubber products.

This, in general terms, gives us an idea of the composition of manufactured rubber articles—rubber, sulphur, accelerator, metallic base, reinforcing powders, mere fillers, pigments, dyes, reclaimed rubber, softening agents. Out of these the rubber chemist chooses the ingredients which will yield a vulcanized product possessing the specific properties required.

The Art of Compounding.

The art of compounding was formerly a matter of the utmost secrecy in the rubber factory. No stranger was permitted a glance into the mixing room. Not even connection with an educational institution served as an "open sesame." One entered an anteroom and looked through a little hole or window just large enough to frame a human face, humbly asked for permission to see "the works," and was shown into the shipping department. In those days compounding was largely a matter of rule of thumb methods. Certain substances were used and brought about certain results. No one knew clearly how or why. The manufacturer was inclined to believe he had trade secrets which his competitors were trying to steal. But at the present time our chemical journals carry numer-

ous reports of researches on rubber; the industry has, indeed, periodicals devoted to its own interests, and there are a number of textbooks on this branch of industrial chemistry. Secrecy has, speaking generally, given way to a more liberal policy. There are, to be sure, trade secrets, as there are in many other lines of manufacturing. But a visitor provided with proper credentials is now accorded a most courteous welcome and is permitted a glimpse into the mysteries.

Let us ask our guide some questions and make note of the information he so willingly provides. Here are a few memoranda:

Elastic Bands.—Pará rubber, 5 to 6 per cent. of sulphur, and accelerators. No compounding ingredients. Rubber tubing, sheeting, etc. characterized by the term "pure gum," have the same composition. We have in such products great elasticity and high resistance to breaking, but not sufficient firmness to withstand abrasion.

[Bands are cut from tubing on a machine built on the plan of a guillotine. Wet rubber may be cut readily. Even a wet knife will readily cut rubber tubing.]

Dentists' Rubber Dam.—Pará rubber, vulcanized in vapor of sulphur chloride, S_2Cl_2, which forms an additive compound with the sulphur hydrocarbon, just as elementary sulphur does.

Surgeons' Gloves.—Made from rubber cement, which is raw rubber dissolved to a colloidal solution in gasoline. Made by dipping porcelain molds repeatedly (five to ten times) into the cement, to obtain adequate thickness. After drying the glove is vulcanized in vapor of sulphur chloride, or is dipped into a solution of this chemical (2-4 per cent. strong) in carbon disulphide.

Bathing Caps.—Pará rubber, 75 to nearly 90 per cent., about 5 per cent. of sulphur, about 5 per cent. of oil for softening, some accelerators, dyes, and pigments. White bathing caps may contain nearly 20 per cent. of zinc oxide, which also improves the strength of the products.

Air Cushions.—Pará rubber about 50 per cent., sulphur 1½ to 2 per cent., and zinc oxide, and filler, which may be whiting or may be a filler which imparts color.

Bulbs.—Pará rubber, about 45 per cent., 6 to 8 per cent. of sulphur, zinc oxide and whiting for white bulbs; zinc oxide, whiting, and carbon black for black bulbs. The latter may also contain lead compounds, which in the vulcanizing forms black lead sulphide.

Hot Water Bottles and Similar Articles.—Rubber, various grades, 20-30 per cent., about 2 per cent. of sulphur, zinc oxide, whiting, white clay, in some cases some rubber substitute. Golden sulphuret of antimony may replace the sulphur in goods of tan or reddish-brown color. Various pigments and dyes for special colors. A variety of grades of these goods are manufactured. The sulphur content is kept low to prevent "bloom."

Rubber Sponge.—Pará rubber, varying proportion, some oil, or oil and wax, to soften, some filler, which in cheap sponges may exceed 50 per cent., and some ammonium carbonate (about 8 per cent.), incorporated, to decompose during the vulcanization, and to produce carbon dioxide and ammonia gas, these gases causing the rubber dough to "rise" and to become porous, just as carbon dioxide, from baking powder or yeast, gives lightness and porosity to bread or cake dough. The rubber sponge of average grade contains about 25 per cent. of rubber. It may also contain some "white substitute," described under Rubber Erasers.

Rubber Tubing.—A variety of kinds and grades are made. The tubing may be made of Pará rubber and sulphur (about 5 per cent.) with accelerators, but no reinforcing or filling material. This variety is known as pure gum tubing. Or it may be made to contain as much as 50 per cent. of zinc oxide as reinforcing material. This does not cheapen the product, for zinc oxide of the quality used costs more volume for volume than the raw rubber. It is added to produce a firmer product. Cheaper white tubing is made from lower grade raw rubber, with additions of rubber substitute and mineral filler, such as whiting, with probably a little vegetable oil to facilitate the incorporation of large quantity of dry material. Barium sulphate is employed largely as filler in cheap rubber products, particularly if the "rubbery feel" is not to be lost. Cheap tubing contains about 15 per cent. of rubber.

Rubber Stoppers.—These also may be of the pure gum variety with no reinforcing ingredients or filler. Common rubber stoppers, if white in color, contain zinc oxide, clay and whiting; sometimes rubber substitute, with a little vegetable oil. Wringer roll dust may be incorporated. There may be as little as 10 per cent. of new raw rubber used in the mixture. Black stoppers may contain reclaimed rubber, carbon black, and lead compounds, which are converted into lead sulphide. The average amount of new rubber used is about 30 per cent.

It may be of interest to students that holes may be bored in rubber stoppers with a common cork borer, wet with sodium hydroxide solution, or even with water.

Pencil Erasers.—Pumice stone (about 10 per cent.) is added to impart abrasive quality, and "white substitute" to reduce cohesion between the rubber particles, so that after vulcanization the product is soft, wears away when used and does not unnecessarily roughen the paper. Zinc oxide is used to some extent; so also are whiting and various pigments. Ink erasers contain more pumice, and this in a coarser powder, and in some there is finely ground glass. ("Substitute" is made by boiling corn oil with sulphur. The product may be vulcanized, yielding "white substitute.")

Rubbers.—Black being the most popular color, the rubbers have for years been made from composition containing litharge, or other lead compounds, which in the vulcanizing produce black lead sulphide. At the present time, however, carbon black is the popular reinforcing material to raise the stress-strain curve, and at the same time to act as a black pigment practically impervious to light, thus retarding "sun crack," so frequently noticed in the rubbers of yesteryears. The rubber composition for the uppers is different from that of the sole; but speaking generally, whiting, strange to say, or china clay, are common fillers for rubber footwear composition. Reclaimed rubber is used to a considerable extent, particularly in soles, the higher grades of which may contain as much reclaimed as new rubber, and the cheaper grades considerably more. Asphaltum and asphaltic petroleum residue may be used to some degree.

Rubber Heels.—The composition is similar to that for soles. But finely ground fibre of cotton, wool, linen, etc., is usually included.

Pneumatic Tires.—The tread is made particularly tough and firm, yet with a high stress-strain curve. A few years ago some manufacturers made white treads with zinc oxide as reinforcing material. At present the tread of all standard makes is black in color, carbon black having been found more efficient. There may be present also a little litharge, or magnesium oxide, and a little tar or oil to facilitate the incorporation of the carbon black which is used in the ratio of about twenty to thirty pounds to a hundred pounds of raw rubber. In cheap tires the tread may contain clay as filler.

The side walls of the tire may contain a mixture of Pará rubber (for strength) with softer rubber like caucho. Over-vulcanizing must be avoided lest the tire age quickly. Carbon black, 10-25 per cent., zinc oxide, etc. are employed for reinforcing. The frictioning used on the fabric or cord serves as a lubricant, so that the threads in the repeated flexing of the tire do not wear against each other. It is much softer than the tread, and is made of a mixture of raw rubber, usually including Caucho or African, as well as some Pará rubber. Zinc oxide and the usual vulcanizing materials complete the formula.

Inner tubes may be of the same composition as rubber bands—about 93 per cent. rubber. Or they may contain a small amount of zinc oxide. The red tubes may have been vulcanized with golden sulphuret of antimony.

Rubber Belting.—Usually made of soft raw rubber, with litharge, barium sulphate, and whiting. It contains about 8 per cent. of sulphur, and from 35-40 per cent. of rubber. In the rubber covering compound reclaimed rubber may be used.

Rubber Matting.—Soft raw rubber, reclaimed rubber, whiting, clay and other mineral filler, lead compounds (for color) and zinc oxide. But a more durable product is now made from Pará or plantation rubber, carbon black as reinforcing agent, and a small amount of mineral filler.

Hose.—The difference between hose and tubing is that the former is built up of cotton fabric "frictioned" with a rubber com-

position similar to that used in pneumatic tires, while tubing contains no fabric. For cheap hose a great deal of reclaimed rubber, rubber substitute, and mineral filler is used, and only a relatively small amount of new raw rubber. But the composition of the rubber covering is devised to yield a product which will resist abrasion, and is much tougher than the frictioning which covers the individual layers of fabric.

Hard Rubber.—For such articles as combs, Pará or plantation rubber, and sulphur, in nearly equal quantities, are employed together with appropriate pigments. For syringe pipes the sulphur content is lower—about 30 per cent.

Storage Batteries.—Raw rubber, balata, black substitute, clay and sulphur (about 15 per cent.).

In all kinds of hard rubber products hard rubber dust may be utilized, together with mineral filler and pigments.

The Branches of the Rubber Industry.

The rubber industry of America manufactures some fifty-odd thousand separate articles. But specialization has been carried to a considerable extent, and in some factories only a single line of rubber goods is produced. There is, for example, the hard rubber industry, with its subdivision of electrical supplies, battery cells, and toilet articles, such as combs, brush handles, etc. And, speaking of soft rubber, the manufacture of belting, packing, matting, hose of all kinds, insulated wire, has grown to great proportions. Druggists' sundries, surgeons' and stationers' supplies, household articles, toys, too numerous to mention, are made in great quantity. Dentists' material and rubber stamps have become necessities. Rubberized cloth is made for various uses. The footwear business has grown to an astonishing degree, and a pair of rubbers is made annually for more than 75 per cent. of the population of the United States, while nearly 50 per cent. of all the men, women and children now walk on rubber heels. Tennis shoes, golf balls, and other goods of rubber play an important role in sports. But the greatest department of the rubber industry has to do with the manufacture of tires. This country imports two-thirds of the entire rubber crop of the world; and about three-fourths of this immense quantity goes into tires—

pneumatic tires, solid tires—tires for trucks, tires for baby carriages, tires for bicycles, but above all else, tires for automobiles, of which about fifty million are now made in a year.

The Machinery in the Rubber Industry.

To tell the story, even in outline, of the mechanical features of mass production processes in these various lines is precluded by the limitations of time—and of space—when this lecture goes to the printer. It's "another story," as Kipling says, one which deserves to be told by aid of a "movie film." But we might, in conclusion, take a mere peep into one of the great factories of Akron, which is the chief center of rubber manufacturing in the world. The first step in all rubber manufacture consists in plasticizing the raw rubber, in order that the compounding ingredients may be incorporated. This is done usually by the aid of a machine constructed on the general principle of a clothes wringer. But the rollers rotate against each other at different speeds, thus producing a grinding or wiping effect. In case of wild rubber, impurities are to be removed. This is done on a mill of special type, having hollow rollers which may be heated with steam, or, later in the operation, cooled with water. A stream of water is made to play upon the rubber as it revolves, wrapped about the rollers. The washroom is a messy, noisy place, and, when African rubber is being washed, is an offense to the nostrils. After the washing, the rubber must be dried, which is frequently accomplished *in vacuo.* Plantation rubber, however, does not require washing, and goes direct to the mixing mill, which is similar in construction to the mill previously described. The friction and the heat produced as the rubber is chewed by the rollers revolving at different speed makes it plastic, so that compounding ingredients may be worked in. The operator shovels the dry powder upon the rubber as it enters between the rollers, and the machine does the rest. The resulting rubber mixture resembles putty or stiff bread dough in consistency, and is now ready for shaping. It may be spread upon textile fabric, may be rolled out into sheets, or passed through a "tubing machine," or molded, although, to be sure, the composition and hence the physical properties of the mass are made to vary in accordance with the subsequent steps of manufacture contemplated. Raw rubber, and, particularly, plasticized rubber, is adhesive. So a tire, or a rubber shoe, may readily be built up over a form without the use of much cement.

The final step of the processing is the vulcanization. This procedure differs materially with the nature of the articles to be "cured." A tire, for example, is enclosed in a metal form, called a pressure mold, for within the tire there is placed an airbag, which is essentially a strong inner tube, and this is inflated, so that the tire presses firmly against the inner walls of the mold. Rubber shoes are also made largely in pressure molds, though some firms still vulcanize footwear on racks in closed, heated compartments. A vulcanizer for tires is a large, tubular compartment, holding twenty-odd tires, and capable of being closed airtight.

The machinery needed to mix the rubber composition, to do the shaping, to facilitate the assembling, and to convey the materials, the partly finished, and the wholly finished articles, hither and thither, until they finally land in the shipping room, is in itself a worthy text for a story. We wonder what Charles Goodyear would say to all this—or the crew of Columbus, who knew of nothing that could be done with caoutchouc, except to bounce it. And now we are beginning to use rubber for paving blocks.

What in fact is the future of the rubber industry? Its possibilities stagger the imagination. We are entering, as Dr. Greer says, upon the "Reign of Rubber."

INVISIBLE LIGHT.

By Henry Leffmann, A. M., M. D.

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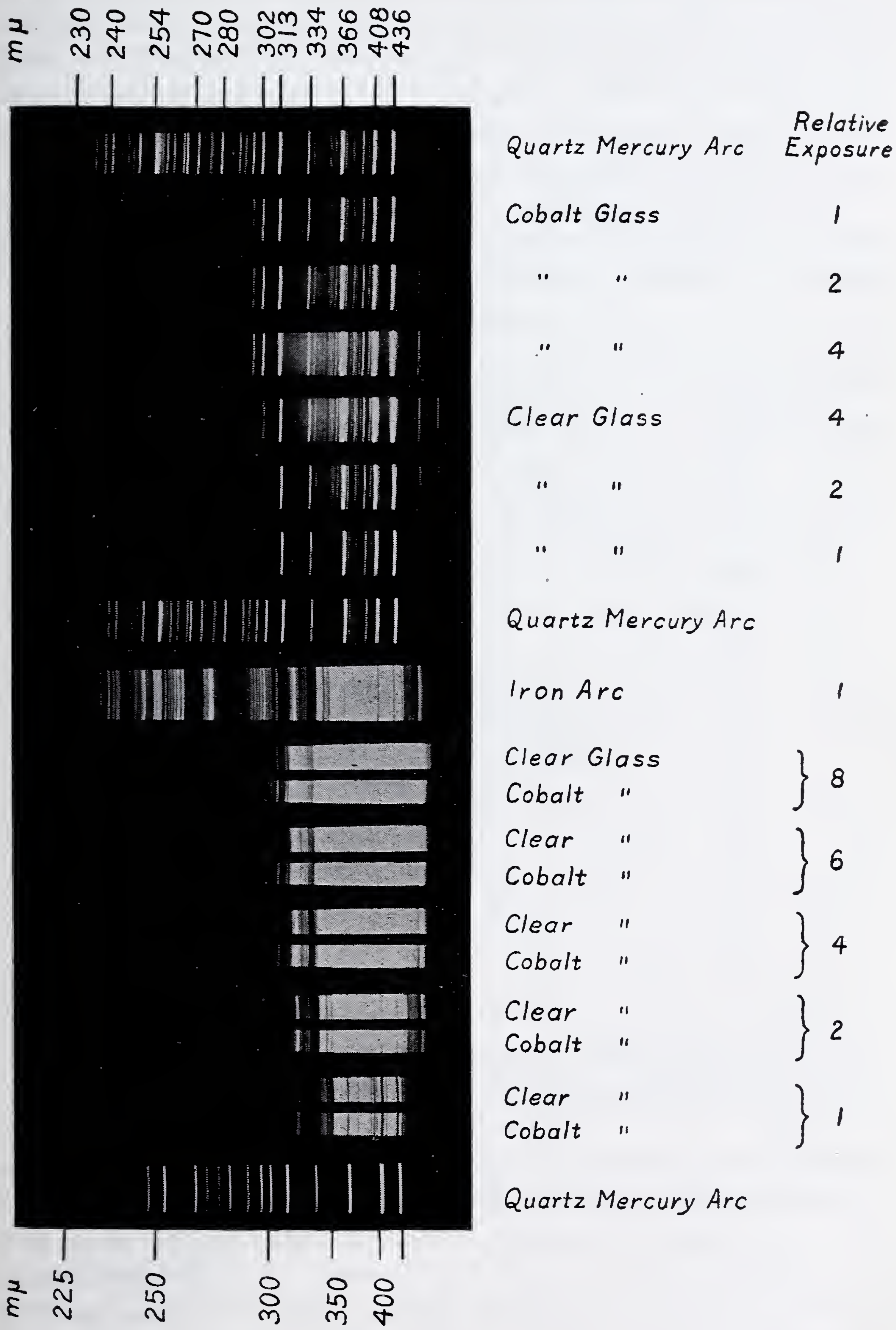
"Invisible light." The term seems ill-chosen, for light is essentially the form of energy connected with visibility. Indeed, a step has been taken lately to eliminate the paradox, by using the terms ultra-violet and infra-red "radiation." No doubt some such designation will before long be in general use among scientists, but technical phrases are not very acceptable to the non-scientific portion of the community.

The nature of light was not definitely known until about the time when William Penn was preparing to found the city of Philadelphia, when Isaac Newton discovered that by passing a beam of light through a prism, all the known colors were exhibited. He made his experiment in a dark room, the beam of light coming through a hole in a shutter. He noted that the beam was bent from its course, violet to the greatest extent, red the least. The colors were somewhat arbitrarily distinguished; conventionally, they have been given in the order: violet, indigo, blue, green, yellow, orange, red. Great advances have been made from Newton's time in the knowledge of color relations, and it is now known that a few colors can be so chosen as to make any color or shade desired. In photography and in printing vivid results are obtained by the judicious use of a few color screens.

By using a comparatively large opening for the beam of light, Newton was prevented from observing a very interesting and important feature of the "solar spectrum," as the sheet of color he obtained from sunlight is called. Wollaston, an English scientist, using a narrow opening, observed that the spectrum is crossed by numerous dark lines, indicating that certain tints are missing. He did not investigate the matter to any extent, but later, Fraunhofer, a Munich optician, mapped some of the more conspicuous lines and designated them by letters of the alphabet. Newton thought that the visible spectrum represented the entire range of the beam of white light that was passing through the prism, and such was the opinion held by scientists for over a century. In the first decade of



Transmission by clear and cobalt glasses of rays from bare iron arc and quartz mercury lamp. Wave-lengths in micro-microns. From paper by Luckiesh, Halladay & Taylor. **(J. Frank. Inst.,** 1923, v. 196, 353.) **Courtesy of The Franklin Institute.**

the nineteenth century, Sir William Herschel discovered that beyond the visible red are rays that have definite effects. About the same time Johann Wilhelm Ritter discovered rays beyond the violet. Since these discoveries, the nature and properties of the invisible rays have been extensively studied and it is known that they extend in both directions far beyond the visible spectrum.

The nature of light has, of course, been always a matter of interest to scientists. Aristotle had a theory about it. Newton regarded it as due to the transmission of corpuscles through space, but for many years the accepted view has been that it is due to vibrations, somewhat analogous to those which transmit sound, but differing therefrom in important points. Sound waves are transmitted through the air or other material which connects the sounding body to the ear, but light does not appear to be so transmitted. Sound waves are propagated from place to place at about 1140 feet per second; light travels 186,000 miles in the same time. The rate of vibrations, that is, the number of to and fro motions per second for sound ranges from sixteen per second to about 25,000, but light vibrations run up to many millions. The length of the light wave is taken as the datum of distinction. This is now usually expressed in a specific unit, termed the Ängström unit, represented by Ä. It is one ten-millionth of a millimeter. Many physicists, however, use the micro-micron, which is the millionth of a millimeter. Each micro-micron, therefore, is equal to ten Ä. The visible spectrum reaches from about wave-length 4000 Ä (violet) to 8000 Ä (red). The X-rays, now so much used in medical practice, are ultra-violet and very short; radio transmission waves are far beyond the visible red and very long. The dark lines, seen in the spectrum of the sun and of many fixed stars, have been recognized as due principally to the interfering action of highly-heated gases, and are thus indicative of the elements that have produced these gases. It has been further ascertained that solid objects if emitting light, produce a continuous spectrum without dark lines, so that it is now possible to determine whether a celestial object is solid or gaseous. By extended research, many of the lines have been identified as due to particular elements. A double dark line in the yellow is known to indicate sodium. When sodium compounds are heated strongly, similar yellow lines are seen. Very small amounts of material are sufficient to give distinct lines in a properly constructed apparatus. This instrument, termed a spectroscope,

has been of great advantage in both chemistry and physics.

In a total eclipse of the sun that occurred in 1868 J. Norman Lockyer, a British astronomer, observed in the outer portion of the sun's atmosphere an orange band that he could not refer to any known element. He, therefore, assumed that it was due to an element existing in the sun, and provisionally called it "helium," from the Greek word for sun. Many years afterwards this element was found in minute amount in a rare mineral, and still later, a notable proportion of it was found in the natural gas from wells in the

	Exposure
C-2 Daylight Glass	8 Minutes
Soda-Lime "	8 "
Quartz Mercury Only	40 Seconds
Blue-Green (Copper) Glass	8 Minutes
Boro-Silicate "	8 "
Soda-Lead "	8 "
Soda-Lime "	8 "
C-2 Daylight "	8 "
C-3 Photographic "	8 "
Blue-Green (Copper) "	4 "
Boro-Silicate "	4 "
Soda-Lead "	4 "
Soda-Lime "	4 "
C-2 Daylight "	4 "
C-3 Photographic "	4 "

Transmission of rays from quartz mercury lamp through different lamp-bulb glasses. From paper by Luckiesh, Halladay & Taylor. **(J. Frank. Inst., 1923, v. 196, 353.)** Wave-lengths in micro-microns. **Courtesy of The Franklin Institute.**

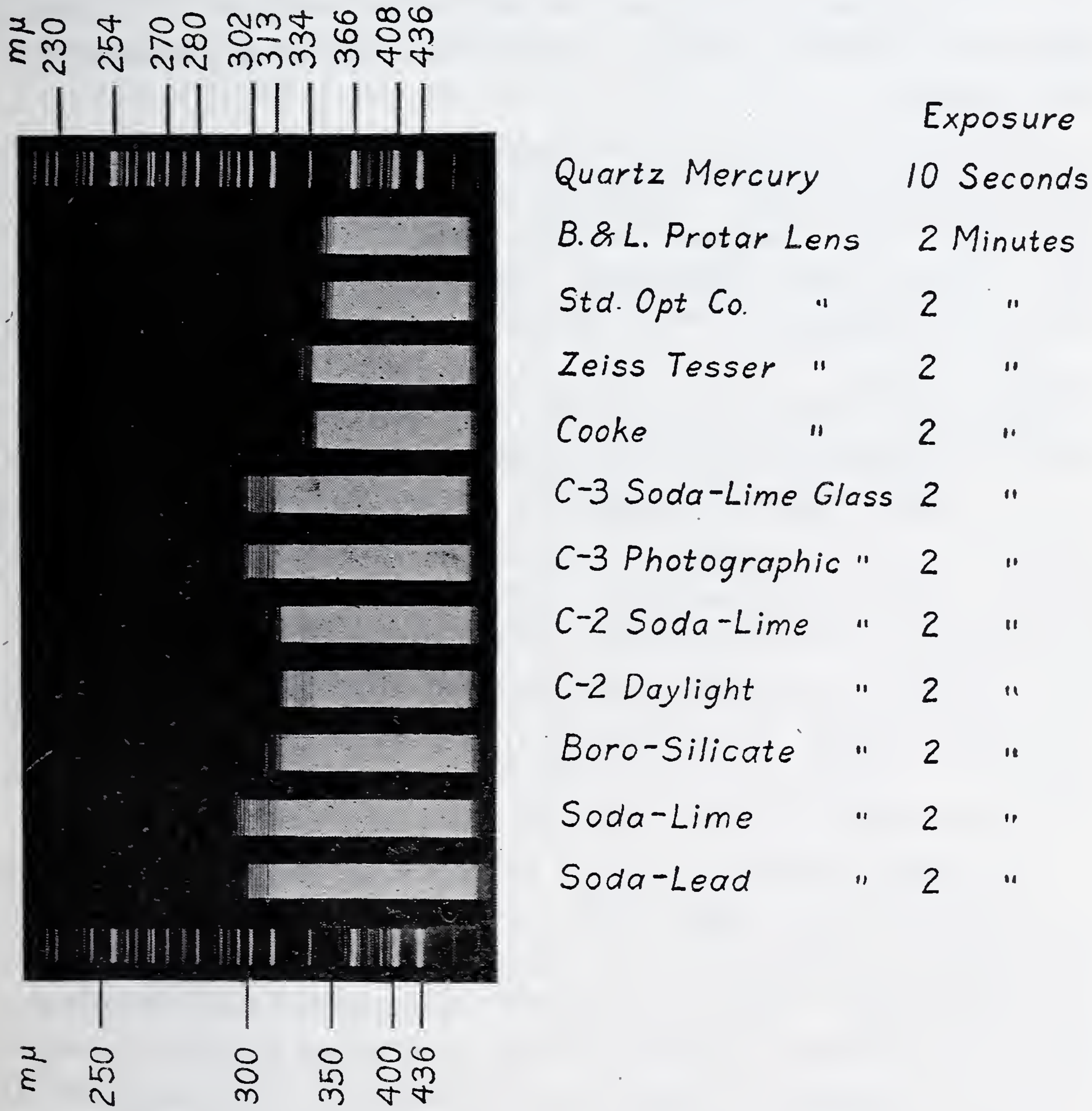
middle southwest of the United States. Large quantities of helium are now available and it is used for filling United States dirigibles, as it is the lightest substance known except hydrogen and is non-inflammable.

The study of the infra-red and ultra-violet rays has been pursued of late years with much activity. Ultra-violet rays are obtained in several ways. They exist in sunlight but not in large amount. Electrical discharges at high voltage, especially from iron, cadmium

or mercury terminals, give a good range of such rays. The Cooper-Hewitt mercury arc is rich in them. The rays, however, do not pass freely through many substances. Glass, mica, all films used for motion picture work, gelatin and many other materials perfectly transparent to ordinary vision obstruct completely the transmission of the rays. The very short vibrations are obstructed by air so that researches in this part of the spectrum must be conducted in a vacuum. Quartz, fluor spar, and some pure cellulose products transmit these rays. Infra-red rays, which have apparently not been studied as extensively as the ultra-violet show higher powers of penetration through ordinary transparent objects, indeed, in the extreme field of infra-red remarkable powers of penetration exist. The waves employed in wireless telephony and broadcasting are infra-red of very great length, and penetrate thick walls, for it is possible to hear the ordinary broadcasts from aerials stretched in closed rooms and cellars.

As the rays beyond the visible spectrum are wholly invisible to human eyes, the question at once arises how do we know of their existence? They are detected by their actions on various substances. For instance, substances exist that have the power to reduce the rate of vibration, so that they are brought within the range that the human eye can perceive. Such substances are termed "fluorescent." Willemite, a natural form of zinc silicate shows this property to a high degree. Several coal-tar colors are strongly fluorescent even in dilute solute solution. One such compound is called "fluorescein" on account of its activity. Solutions of quinine, especially the sulphate, have distinct fluorescence. Horse-chestnut bark contains a crystalline principle "esculin" that shows the property to a moderate degree. Many fluorescent substances are capable of acting under the influence of ordinary light, but the accessory light interferes with the brilliancy of the effect, hence it is most vivid when excited by ultra-violet radiation alone, which can be carried out in darkness, and the fluorescent substance seems to be emitting light. Many brilliant effects can be produced by this means. The electric spark, when transmitted through tubes nearly exhausted of air can pass over a considerable distance, and is usually accompanied by considerable ultra-violet radiation, so that fluorescent substances placed in such tubes show vividly when the spark is passed. As glass does not transmit these short waves, the substance must be placed inside the tube. Its fluorescence is due to emission of rays

visible to the human eye, which can pass through glass, and therefore, it seems to be self-luminous. It is merely taking up the invisible light and rendering it visible. Among the substances that have this property of fluorescing under electric discharges in vacuum are compounds of uranium. Glass colored with uranium is yellowish-green under ordinary light but assumes under the electric discharge a deep green brilliant tint.



Transmission of rays from bare iron arc through different lamp-bulb glasses and photographic lenses. Wave-lengths in micro-microns. From paper by Luckiesh, Halladay & Taylor. (**J. Frank. Inst.,** 1923, v. 196, 353). **Courtesy of The Franklin Institute.**

Ultra-violet light acts promptly on the ordinary photographic emulsions, hence it can be easily detected by these. The range of susceptibility of such emulsions extends to a considerable distance, for X-rays, which are very short, produce, as is well known, very distinct pictures after brief exposure. The penetrability of X-rays is also a striking property, passing through almost all opaque mate-

rials except metals. Bone resists some of the rays, but by using a high-power tube, generally called a "hard" tube, penetration even of bone may be obtained.

Ultra-violet rays are injurious to most, if not all living organisms. Such light will coagulate albumin. Brief exposure of the eye to it will result in blindness, and even the ordinary skin may be injured. On the other hand, brief exposure of skin affected with certain diseases has been found to be beneficial. Extensive application has been made of ultra-violet rays in the treatment of some diseases.

Infra-red rays seem to have been much less extensively studied than the short waves. They have more or less heating effect, and are directly connected with the heat portion of the spectrum. They pass through many substances, including glass, mica and other transparent materials. They can be separated from white light by means of screens. A red screen is now furnished by dealers which transmits only infra-red rays. Peculiar effects are obtained when ordinary landscapes are photographed. Trees in full leaf give pictures in which the leaves appear as if covered with snow. During the late war use was made of screens of this nature to distinguish between real and camouflaged foliage. It was a practice of the belligerents to cover the ground with painted strips to deceive airplane raiders, who would think that the view was that of foliage concealing cannon or ammunition, and waste bombs on it. By means of a screen, devised in the Eastman laboratory, the aviator could distinguish between real leaf-green and green paint.

Infra-red interferes to some extent with the ultra-violet, and even with effects of visible light. Several luminous phenomena are developed, as noted above, by visible light, but more strikingly by ultra-violet light. These are especially, fluorescence and phosphorescence. Fluorescence as already noted, is regarded as due to a reduction of wave-length, by which the invisible wave is brought within the limit of human vision. Phosphorescence is the storing up of light. The substance shines for a variable time—generally short—after the light is removed. Some forms of phosphorescence are, however, merely slow combustions, and are not due to any absorption of light. Such are the glow of phosphorus itself and the light of the glow-worm and firefly. The glow, often quite brilliant, exhibited by rotting wood (fox-fire) is also due to chemical action and is not true phosphorescence. The term should be limited to those

instances in which no appreciable chemical change occurs in the glowing substance, but the action seems to be due to an actual storing up of light, the substances not showing any light unless previously exposed to either visible or invisible rays. Several metallic sulphides, especially of zinc and calcium exhibit this true phosphorescence. It appears that these do not act well unless somewhat impure. Absolutely pure materials are inactive. If a surface coated with calcium sulphide properly prepared, is "activated," that is, exposed to light until it acquires marked phosphorescence, which, of course, should be observed in the dark, is then subjected to the action of light passing through a red screen, the phosphorescence is destroyed. In some biologic researches, it has been found that infra-red light interferes with the action of the ultra-violet. On the other hand it is claimed that infra-red rays have high penetrating power in living tissue and are useful for therapeutic purposes.

Although a good deal of work has been done in the field of invisible light, it is evident that a vast amount of interesting and useful information still awaits discovery and application.

IDIOSYNCRASIES, OR THE STORY OF A SNEEZE.

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Idiosyncrasy is the term applied to a characteristic possessed by certain individuals whereby they are disagreeably affected, or even violently dislike things that are harmless or agreeable to a large majority of their kind. The word itself is not so very common, but the occurrence of the quality which it describes is only too common, and there is probably not a single person in this room tonight, who can honestly profess in the words of that famous song of songs, "Yes, we have no idiosyncrasies today."

Indeed idiosyncrasies are often highly desirable qualities and for some purposes they are considered exceedingly fashionable. The whole world revolves around them, for if we had them not, what a harmless lot of standardized, systematized, pattern-made mollycoddles we would be. If we all liked the same things, if the same things all liked us—if we all thought the same way, if we all reacted alike to the same impulses—if we all behaved alike, if we all looked alike—and we would if our respective and respectable body cells were likewise devoid of idiosyncrasies—what an uninteresting, inert, inane and inanimate crowd of protoplasmic puddingheads we would all be. We should, therefore, be properly thankful for some kinds of idiosyncrasies. Others are nuisances and are to be treated as such.

Now there are innumerable types of idiosyncrasies. Roughly speaking, however, these peculiarities or antipathies as they are called, may be classed into two groups, namely, the congenital kind and the acquired kind, and I may say that there are certain borderline cases that may be argued into either class. The congenital are those which come to their proprietors through a generous provision of heredity. They are the genealogical idiosyncrasies that may be very conveniently, and sometimes quite properly attributed to the queer caprices of a great grandfather in the remote ago. For some odd reason or another, grandfather always gets the blame for anything uncanny that comes to ail his progeny despite the fact that the Bible in its oft-repeated classic, *"even unto the third generation,"* carefully avoids making a sex distinction. So whether the congen-

ital idiosyncrasy may be dietary, emotional or etiologic, we often hear, "Well, his grandpap never liked pumpkin pie, either," or "His grandpap had an awful temper, too," or "No wonder—his grandfather had the hay fever, too." Poor old grandpap!

So we dispense for the moment with the idiosyncrasies of true heredity.

The other class—the idiosyncrasies of environment—may be further subdivided into the truly innate, organic idiosyncrasies acquired through physiologic or psychologic causes, and the idiosyncrasies of eccentricity and caprice suggested by a resourceful perversion and perpetuated by force of habit.

Of the first mentioned, namely, the truly innate organic acquired idiosyncrasies, might be mentioned as example, one due to a child having been injudiciously terrified with some object, the mental impression becoming fixed and permanent. Antipathies of this sort also come from mental association, often unconscious or subconscious, of one object with another admittedly displeasing and repugnant, or perhaps with some painful or distasteful experience in the past life of the person affected. For instance the writer has a distinct idiosyncrasy to grape juice, despite Mr. Bryan's intemperate advocacy of this temperate imbibition. He can date this antipathy—which has by this time evolved from the psychologic to the physiologic—to a rare day in June when to conceal his incursion and raid upon his good mother's store of home-pressed grape juice, he found it necessary to conceal in and about his person, all liquid evidences of his petty larceny by drinking without let-up the total contents of a quart bottle of lukewarm grape juice. Since then, and by virtue of some unconscious contract, his stomach has come into full accord with his mind, and today grape juice to this person is not a pleasing drink but a nauseant vile concoction, only to be indulged in when an emetic is required.

Sometimes a true poisoning is improperly called an idiosyncrasy. For instance, were it not indelicate I might mention an affair which a certain small family had with a sextette from Lucifer of decrepit, ill-bred and malevolent oysters. Henceforth to this same small family Bivalve, New Jersey, is in the Tropic of Capricorn, and oysters are rare minerals.

The second class in the group of acquired antipathies comprehends the so-called idiosyncrasies of eccentricity and caprice suggested by a resourceful perversion and perpetuated by force of

habit. These are not true idiosyncrasies. "John doesn't take sugar in his coffee," or "Bill never uses salt," "Doris cannot take castor oil"—these were all caprices originally—eventually they became an ingrained habit. John doesn't take sugar in his coffee today—not because he has an aversion to sweet things—not because his body cells are sweet enough and require no further saccharization, but probably because John when he was a boy, thought it was smart to be different from the common run of coffee drinkers. Or John felt that his existence was being ignored at the dining table or in his mother's sewing circle, and so he set himself apart as a different person simply by denying himself the cosmopolitan sugar. John early in life thus gained a peculiar publicity, and the habit he started then becomes part of his daily drudge—to satisfy a foolish whim he victimizes himself for life—becomes a sugar hater, and dies totally ignorant of the blessed sweetness of a cup of good coffee. In this connection it might be recalled that the well-known advice of "The Duchess" in "Alice":

"Speak gently to your little boy,
And beat him if he sneezes;
He only does it to annoy,
Because he knows it teases,"

contains much sound advice as well as some unsound. Confirmation of this belief is now produced by the National Committee for Mental Hygiene.

For its report agrees with the theory of all but the second line of the verse; but it is emphatic in the statement that youngsters soon learn whether tantrums are profitable or otherwise. If they feel they can get something out of them they proceed to have them as occasion demands.

Take the tobacco habit. The body cells cordially hate it when with its juices "they are first acquent." Normally the human body is antagonistic to tobacco and its ingredients. This is the proper viewpoint to take of the tobacco habit, and in this I am bound to be supported by a certain group of well-meaning old ladies of both sexes, whose present endeavor is to eradicate from this land of the free and the home of the rave the pernicious, life-destroying weed familiarly known under such *nom de plumes* as Camels, Cincos and cut plug. I may be pardoned for referring at this point again to a strictly personal matter on the ground, perhaps, that it has been a strictly personal matter with most of the gentlemen in this audi-

ence. I say gentlemen advisedly, although it is alleged and rumored that this pernicious habit is extending its engulfing and paralyzing tentacles into feminine circles heretofore considered immune to its vicious influences.

But that is another story—we men all agree, however, that if the weed plays fair and exacts from its lady initiates the nauseating, quintessence of seasickness that it exacted from us, its primary shriners, we shall never complain. By the way the stanza that Thomas Hood left out of his immortal "I Remember"—is now in public print for the first time.

"I remember, I remember
My first tobacco spree,
The little corner of the plug
That Bob bestowed on me.
Now swallow hard—that's what he said,
And I obeyed, of course,
They took me home a limpid lump
Of over-ripe remorse."

And that, I am certain, is the common experience of all devotees of the weed when first they try its tempting lure.

Around and about the boy's first cigarette or chew of strong tobacco are pressed in never-to-be-forgotten discomfort and discontent—life's darkest, dankest, deepest moments. Generally from then on, however, devotion to the weed is certain. The antipathy exhibited to the tobacco upon the first trial is quickly changed to honest regard, and in a few weeks, months or years, the habit has so grown upon the devotee that not good sense, regard for sanitation, or even the beseeching requests of a lady love can make him forego his old corn cob or his filthy cut of plug. To be satisfied with this statement one only has to watch the honest satisfaction beaming on an old man's face as he sits in his slippers by the fireside, unconsciously conducting an experiment in destructive distillation, a capacious meerschaum still, hiding his countenance, and himself filling the part of an aspirating worm condenser. What a wealth of content he seems to extract out of that luring weed and not even the Shah of Persia smoking his golden chandelier is happier than the bronzed old man condensing the vapors from a clay retort, holding back that which is good and chimneying out in coiling wreaths the incondensible smoke. By the way, I am told of the invention of a smokeless cigar. As a curiosity it may be interesting, but as a commodity

it is worthless. For despite the gaudy lithograph upon the cigar band, and despite the extra coupons, no real man would ever indulge in a cigar that did not offer special attraction by way of smoke, that wisps and curls and purls and spins in endless syncopation.

But the tobacco habit, despite the fact that the body cells are eventually taught to expect their daily dose of nicotine, belongs to the class of capricious and unnecessary idiosyncrasies. An exertion of the will, conducted after clever propaganda and governed by proper principles, is always able to remove such a habit provided it is conceived at a season of the year removed from the New Year and its ephemeral resolutions.

Returning now to the broad grouping of idiosyncrasies, which includes the truly innate inherited and acquired antipathies, we find here the group to which we shall dedicate our attention for the rest of our lecture period. We refer to those antipathies or idiosyncrasies which are not conscious caprices, and which an exertion of the will cannot by any means remove. Antipathies are they which are part of the body economy—queerness and caprices of the involuntary cells or cell groups of the individual. Here mind has no power over matter for of some of these intolerances we can say with correctness that the persons afflicted frequently have no mental aversion to the disturbing article and no emotional control over its peculiar behavior. For instance, some medicines affect particular persons dangerously, even when given in doses much smaller than the normal or average amounts. These medicines act so not because they are distasteful to the mental make-up of the tastee but because the body cell itself resents them. Quinine may be tolerated by some persons in teaspoonful doses—the same dose or even a tenth part of it, might kill another, who exhibits the cell antipathy to it. That is true of all articles of medicine, and particularly so of a few, which because of some un-understood peculiarity in their consumers react in this erratic way. Many alkaloids such as quinine, strychnine, atropine, emetine, the salicylates, benzoates and other organic as well as inorganic drugs behave in this irregular way. The drugs afford no legitimate, reasonable excuse for their hectic abnormalities. And indeed they need not for the blame rests entirely upon the person to whom they are being administered.

It is this erratic record of medical treatment that keeps medicine, at least internal medicine, out of the ranks of science, and labels it art. Surely any practice depending upon irregular, erratic

and empiric applications as medicine does can not be truly called a science. More correctly it is art. Certainly two five-grain quinine pills—the first curing one man's cold, and the other killing its swallower, cannot be termed in high-brow lore, pert instruments of precision.

Then there is the dope habit, which like the tobacco habit, is not a true idiosyncrasy, but rather a converse idiosyncrasy—for these unfortunate habitues acquire not a sensitiveness but a quantitative tolerance for material that to the normal person is nothing short of poison. The morphine or heroin fiend starts with very little capital—a quarter grain is generally enough to soothe his pervert lust—but soon this miserly dose has lost its power and double the quantity is needed. By this token the necessary dose climbs to unbelievable amounts and we commonly find addicts who can accommodate with a sort of impunity doses of narcotic that would kill a dozen normal persons. Gradually the habit grows from a mild whetting of the hungry appetite of a few body cells into a voracious, consuming, destroying influence that sinuously draws into its death embrace every cell in its victim's mechanism. The respectable citizen thus becomes a menace to his community, a shame to his companions, and a digger of graves for himself and his family.

Another converse idiosyncrasy is the alcohol habit. Here, as in the dope habit, we find with emphasis the close interweaving of psychology and physiology—of habit and pathology. Here, perhaps, more vividly than elsewhere, we find the desire for the forbidden, the lust for the lost, finally appreciated and satisfied—only to turn about and grasp its victim in a cold, relentless grip.

Physiologically, however, alcohol is not nearly the menace that the narcotic evil is, but it is the psychologic blunders of prohibition and temperance advocates that have keened and multiplied its dangers. But this is no preachment for or impeachment of prohibition. Suffice it to state that the very choice of the word prohibition is a psychological calamity—for it is natural to want anything that is prohibited—and there are no idiosyncrasies or exceptions to this very human habit. It is this psychology plus the physiology of alcohol that makes the problem of its conquest so remote.

Someone asked me recently if animals other than man exhibited idiosyncrasies. That is a difficult question to answer. But it offers avenues for interesting speculations. Think of a cow with hay fever. One might paraphrase Oliver Herford's purple cow to this extent,

I've never seen a sneezing cow—
I never hope to see one;
But this I *know*—if this is so—
I'd rather see than be *one*.

There are those in the audience, perhaps, who are wondering just when I am going to sneeze. So far in the treatise there has not even been a vestige of a sneeze. And at last we approach it with fear and trepidation, knowing that it constitutes evidence of an idiosyncrasy of much importance to a great and highly specialized group of sensitive Americans. I refer to hay fever.

There are those to whom this twin word brings a reminiscent smile, perhaps a giggle or even a raucous laugh, for it is one of those peculiar words in our heterogeneous language that for some reason or another is only cause for mirth. One of those joy-provoking words or phrases like "whiskers" or "mother-in-law" or "brown derbies" or "bananas," that for no real reason in the world excite our laughabilities and stimulate our sense of humor. But there are those for whom the words hay fever have only the vehemence born of long suffering—and these ill-fortuned sons of man can but unite in one ascending adenoidal roar, as from their blocked and tortured bronchial maze they pour their maledictions upon those pervert humorists who find their precious fever funny.

An occasional sneeze may be excusably ridiculed and laughed at—but when as in hay fever, paroxysm after paroxysm reduces the victim to a state of nervous exhaustion not unlike that of a heart-broken child whose tear duct has been completely drained—then sneezing becomes a veritable tragedy and not a fitful comedy.

And pray, asks someone, what is a sneeze? The dictionary prosaically states that the verb sneeze means to emit a sudden and violent rush of air through the mouth and nostrils, audibly and convulsively—and this, I take it, is a good enough description of the sneeze. It does not, however, explain the purpose of the paroxysm, which in brief seems mainly to be an effort of the body to expel foreign irritants from the nasal cavities. Sneezing is a reflex act, and as such is beyond the control of the will. Often, however, it may be prevented by a strong stimulus to the nasal nerve, such as pressing it at the base of the nose.

Now sneezing may come from a multitude of things, such as chemical or physical irritants. Often the mucous membrane of the nose is so aggravated or sensitized that it sends in an order for a

sneeze at the slightest provocation. Sneezing is often before and after a cold—it seems to welcome the coming and speed the going guest. One pun has it that "A sneezing mortal flirts with eternity"—and surely enough so does a thinking or a breathing mortal, for as Longfellow says:

> "Our hearts though sound and brave,
> Still like muffled drums are beating
> Funeral marches to the grave."

But the sneeze that interests us most this evening is the sneeze of the hay-fever victim.

There is no disease within our ken that seems to fit best into the make-up of the hurrying, scurrying, temperamental Yankee than does this periodic hay fever, so named because hay was once considered as responsible for it. But do not believe the hoax-hucksters that tell you that it is distinctly an American disease. It is universal. Its oddness rests not only in its recurrent visitations but also because it causes its victim as much misery as any non-fatal disease that has ever afflicted mankind, and yet year in year out, with a complacency that is mysterious and awe-inspiring to the outsider, the hay feverite, who for the nonce was racked and torn, comes back at the season's close strong, smiling and apparently uninjured.

Into the forgetfulness of the past he nonchalantly casts the season's last experience and with a dignity that passeth all understanding he awaits the inevitable return of his own particular brand of curse. There is another oddity to the hay feverite and that is his exclusiveness. He belongs to a select crowd, an inbred community whose charter and covenant brook no rank outsiders. Then also he possesses certain elements of fashion for those who seek admission to his lodge must come with good credentials. Frequently certain sensitive persons acquire a running cold, a peculiar acrid hygroscopicity of the nasal mucosa and they proudly acclaim themselves as candidates for the ancient and honorable order of sneezers. Others at odd intervals, through infection or irritation, deliquesce rather copiously from their ocular depressions, their eyes are filled with sabulous itchy dust, and their nostrils exude a sympathetic effluvium. Hay fever—they joyously cry—hoping to qualify without any unnecessary suffering, into the gallant old order.

But the honest-to-goodness hay feverite views these newer interlopers with unattenuated scorn, and bids them off his premises. He knows that a summer cold or a fleeting coryza is nothing like

hay fever. He knows that each recurring year, upon his own red letter date, there comes the vicious caller. Regular as the income tax it appears and only goes away when winter comes to curb its mean tormentings. And every season it performs the same old tiresome drama. Never a novelty to ease the tedium of its dreary stay. Never an intermission between its humdrum acts. Day in, day out, it trails its hapless victim nor leaves him peaceful with the night.

> "For his nights are filled with anguish;
> As his days are filled with tears,
> And his loud stentorian sneezes
> Rip the drums inside his ears."

Credulous and ever searching for relief the victim of hay fever is doubly victimized by quacks and charlatans who prey upon his wearied system. Everything new that comes along in the way of a patent medicine he eagerly patronizes, only to return again and again to his former state of resigned indifference. The scriptural classic of human patience may have been worthy of its day and place and generation, but if there was no ragweed and hay fever in Israel, Job's patience was certainly not properly and thoroughly tested.

Hay fever seizes its victims at divers seasons of the year, depending upon the sensitiveness of the patient to seasonable impressions. It is really due, as we shall see later, to an idiosyncrasy or perhaps a whole parcel of idiosyncrasies. The outer departments of the respiratory organs, such as the nasal passages and parts of the bronchial tract, are naturally coated with a peculiar impressionable lining known as the mucous membrane. This membrane has a diversity of occupations and responsibilities. It is one of the gatekeepers that guard the sacred citadel against invasion. When properly functioning and its integrity is unimpaired, it constitutes a barrier that keeps away all vicious influences, a sort of a fluid moat that guards the castle gates. Its humid surface drowns or stupefies the germs or foreign grains that come to rest upon its damp exterior. But in certain persons, namely, those who cultivate hay fever or similar protein idiosyncrasies, there is a hypersensitiveness of this mucous tissue to some peculiar irritant, cause or object, that would be inactive and inert in the case of one immune to the poison. There is in the sensitive victim an inability to consume or destroy certain foreign particles that aviate about and finally deposit their wares upon his mucous landing-place. Of course it is agreed that hay fever and concomitant conditions are not localized to the nasal

mucosa—for eventually the disease becomes systemic. It is the blood stream that finally becomes the area of excitation.

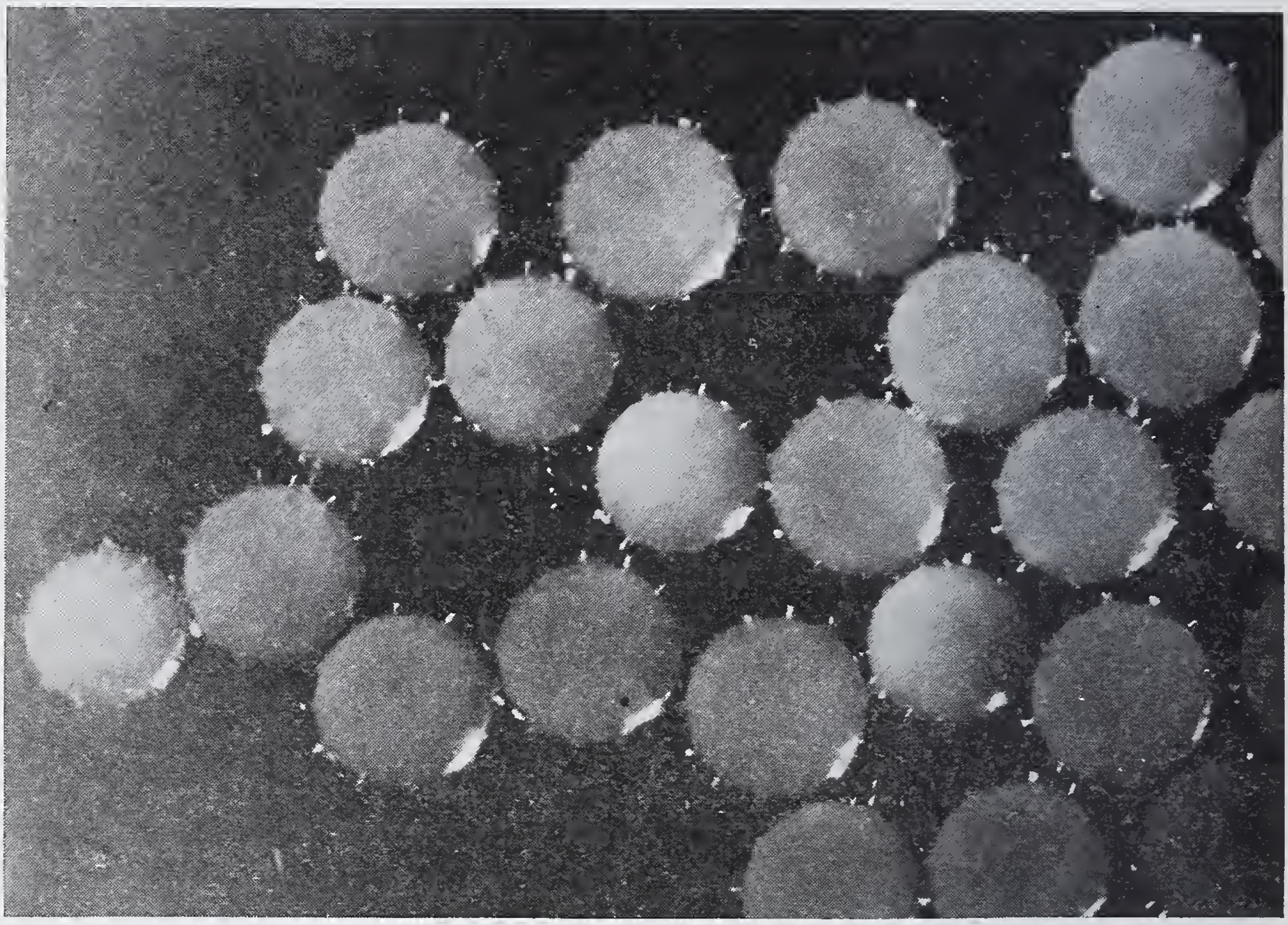
In the true hay fever victim the excitation is accomplished by the pollen of certain plants. The physical form of the pollen is not responsible for the excitation, rather it is their chemical constitution that accounts for their misdeeds. Certain principles of nitrogenous comradeship, known as toxalbumins, for want of a better name, are present in plant pollen and it is these highly complex chemical compounds getting into the circulation that cause all the troubles of the poor hay-fever sufferer. That the pollen is responsible for hay fever has long been known, hence the term pollinosis now used to describe the mean, mean malady in exclusive circles.

The antiquity of the disease and the universality of it is recorded by an Italian medical writer who, as early as the sixteenth century reported patients with headaches, itchy noses and flooding eyes, taken with periodic sneezing fits. And one need not stretch his faculties very tensely to imagine the dilemma of that institution of chivalry of King Arthur's days—the brave knight always looking for trouble—who becomes a victim of rose cold or hay fever. Think of the tumult and clamor of that peripatetic scrap and old iron when his armor clanged and clattered as he sneezed in queer convulsions.

But not until the nineteenth century was hay fever recognized as a clinical entity. John Bostock, an English physician, refers to a peculiar disease that came periodically to swains and damsels of the countryside, whereby, says he, they have a sense of warmth and fullness in their eyes, itching and burning and smarting, and a distaste for light. Their noses are inflamed and blossom out in scarlet splendor. At uncertain intervals, he continues, they sneeze with loud explosions and waste themselves in useless efforts to maintain their breathing space. He further incorrectly attributed the disease to the aroma of flowering grasses. Then came others who, by experiment, proved beyond doubt that pollen and pollen alone was responsible for the hectic affliction.

Another English physician who was himself subject to pollinosis, experimented upon his own person with the pollen from dozens of plant sources. He inhaled it, rubbed it into his nostrils and upon his inner eyelids. He made pills and potions and plasmas out of it, swallowed it and applied it to scarified areas upon his arms and legs. In short, he tried it upon himself in every possible way. His

conclusions were that pollens caused symptoms of hay fever and that the pollens of the grasses were chiefly to blame. He later proved the prevalence of pollen granules in the English air and showed with clarity that flowering plants begin to broadcast their pollen in the early spring. By midsummer the atmosphere is surcharged with these little granules and until the cold of winter numbs and chills the plants' pollinating activities, the air still carries these pernicious particles, pernicious however, only to sensitive persons.



POLLEN OF ROSE OF SHARON, Hibiscus syracus.
A Harmless Pollen. Magnification, Approximately 400 Diameters.

Dunbar later proved that it was the protein or nitrogenous portion and not the starchy portion of the pollen grain that caused the toxic symptoms. Incidentally this pollen that the flowering plant so generously disseminates is part of the regenerative device of the vegetable kingdom. Despite the fact that flowers may exhibit dual sex, the reproductive and fertilizing propensities are not conducted intrapetally. As a rule the pollen of one plant requires transmission through some agency or another (and nature sees to the providing of this agency), to a comrade plant of the same species located perhaps at close range or sometimes at tremendous distances. The presence of pollen in the air therefore is an effort of nature

to perpetuate her chlorophyllic children. Pollen granules floating in the summer breeze carry messages of love from one sweet flower to another. And the breeze is not their only express wagon, although it is the most responsible insofar as the hay-fever sufferer is concerned.

For by sundry and various ingenious devices bees and butterflies and other buggy beasts of burden, are inveigled and prevailed upon to lend their persons to the conduct of these dainty creeds of blossom loves from one sweet creature to another. Those of us who know the blessings of youth spent close to nature will remember the bees with yellow leggings that wheeled their droning flight through summer air, their rear axle smeared with the sticky pollen. Each flower they searched for honeyed treasures requested in return a passage for their golden seed germs, and many the poor passenger bee that fell in the creek a victim to poor judgment in the matter of his freight capacity. But the ways of nature are devious and odd, and the pollen that drowned the bee express is borne by the rushing waters elsewhere to fertilize its kind or start a brand-new hybrid.

Only the pollen cast by the wind is a menace to human intolerants. This scourge is limited to the pollen that is light and airy, that is dusty and easily borne by the breeze. Pollen that is sticky and increases its weight by clumping and grouping, is not a menace for by agglutinating it becomes too heavy to be air-borne. Thus sticky insect-borne pollen comes only from the large attractive flower, the odorous blossoms, for the bee is an esthetic bug and will not visit an inconspicuous plant. Nature, then, has granted to the modest inconspicuous blooms gentle breezes wherewith to effect their pollination.

Thus it is that we find that hay fever is largely caused not by the pollen of large and showy flowers, such as the daisy, aster or dahlia, but by the dusty pollen of small and unnoticeable inflorescence, like the grasses and the weeds. The thoughtless poet calls these weeds—

> "Dear common flowers that grow beside the way,
> Fringing the dusty road with harmless gold."

Furthermore one may generally fix the identity of a culprit plant by noting along with the smallness of its inflorescence the diversity of its individual blooms. For again nature shows ingenuity in insuring the perpetuation of the flowered race by affording

enough blossoms to provide pollen in enormous amounts, so that there will be no question of the survival of the species. Nature knows that the wind is not nearly as reliable as the bug express and in order to be certain that the wind-borne messages get to their destination she wisely sends thousands abroad hoping that one, at least, will get to its journey's end.

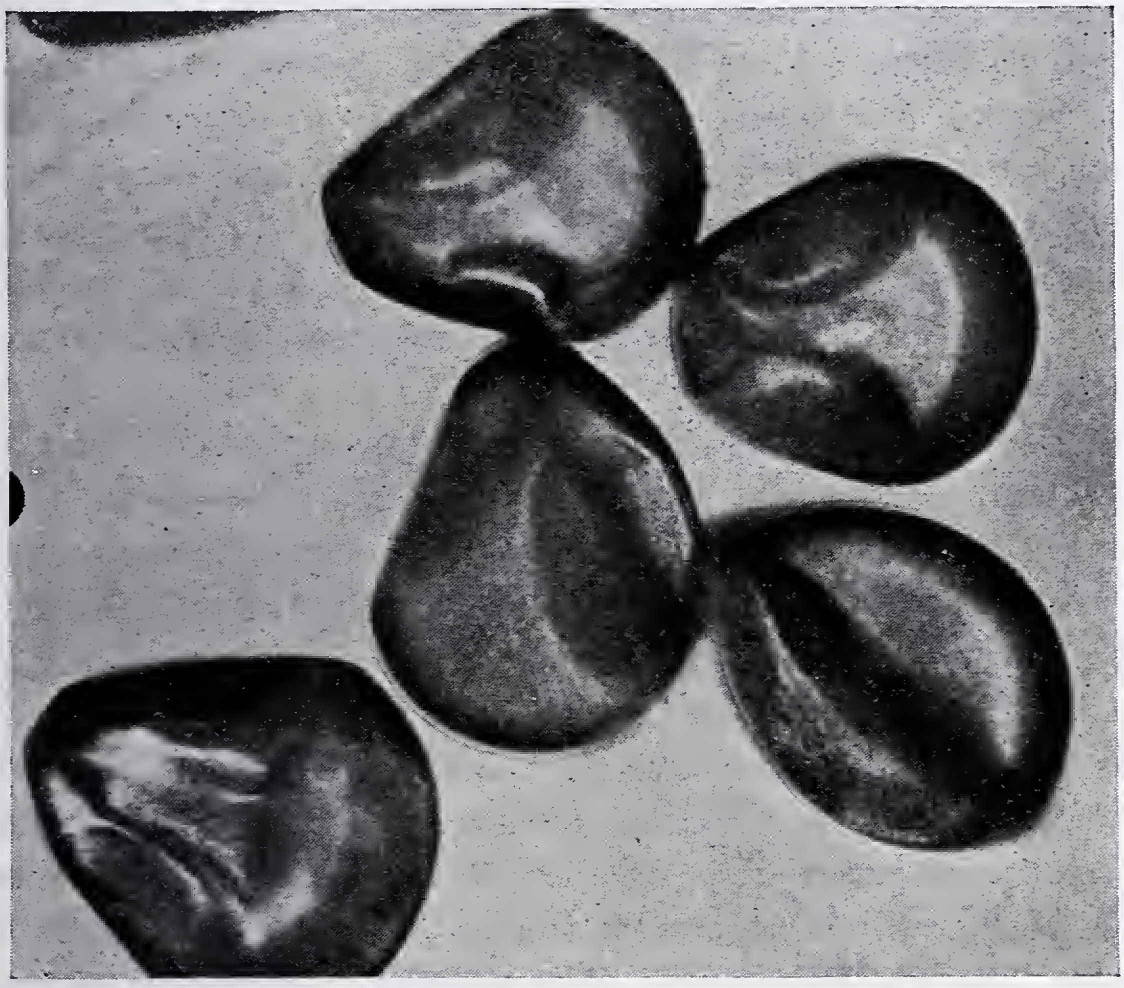
The plants responsible for hay fever, therefore, are those that bloom in innumerable small and inconspicuous florets; and surely

NOT THE LARGE-FLOWERED INSECT POLLINATED PLANT — BUT RATHER THE SMALL-FLOWERED WIND . . . POLLINATED WEEDS AND GRASSES—THAT CAUSE · HAY-FEVER.

enough the grasses with their hidden blossoms, useless ragweed and other kindred weeds, are the chief and consistent offenders.

Hay fever of the late spring and early summer is often erroneously designated "rose cold" or "rose fever." Such a name is a misnomer, for rose cold is hardly ever caused by rose pollen but by pollen from the grasses. In like manner, fall hay fever is popularly attributed to pollen of the goldenrod, while in reality it is caused in the vast majority of cases by ragweed.

The pollen of corn, in spite of its toxicity, is rarely responsible for hay fever; because its size is so great that it cannot travel far; so that only by close proximity to a corn field can hay fever be induced. Rye and wheat also have large pollen grains and, therefore, are of little practical importance as a cause of hay fever. The cereals, however, including rye, wheat, oats and corn, may constitute a local cause of hay fever in some states.



POLLEN OF CORN, Zea mays.

Magnification, Approximately 400 Diameters. (Note Similarity to Grains of Corn.)

The pollens of the coniferous trees and the grasses, especially timothy hay and sweet vernal, are generally the causes of spring affections; the summer grasses, and certain garden flowers and summer flowery weeds cause the midsummer madness, and last, but not least, the vicious late summer ragweeds that are the worst offenders in every clime and region. These good-for-nothing weeds*

*One listener objected to the description of the ragweed as useless, pointing out that it furnished certain wild animals with fodder and also because it furnished the antidote for ragweed pollinosis. In the latter instance one might say with equal eccentricity that the vermiform appendix shall not be termed useless insofar as it furnishes the surgeon with a great many operations.

flourish everywhere, working their evil ways in all directions. Fertile, hardy and useless, they rapidly crowd out less virile plants and promptly change a vacant unused spot into a rank and jumbled jungle. In the East it is between the grasses and the ragweeds that lies the grave responsibility of making countless millions miserable and morose.

We cannot be too harsh with the grasses, however, for they are useful. Someone has called them the overseers of the soil, that bind it to its duty. Were it not for them the soil of hill and plain would emigrate like desert sand and every rainstorm would move a continent to sea. Where grass is master, soil will serve mankind. And then again we owe our daily diet to a kind of grass—the wheat, the corn or rye. But the ragweed is only a pariah in nature's scheme of empire. Good for nothing—vagrant, selfish and vicious, it stands by itself as a nuisance.

On the wing of a breeze, then, the pollen finds its way to the nose of man. Only the sensitive, however, react to its presence and some can with impunity even snuff its very substance into their nasal passages. But the victim of pollinosis reacts to it at once. As soon as it lands on the membrane the itchy news is quickly broadcast to headquarters and an order is despatched for a sneeze. The mucous surface knows at once its inability to cope with its vicious visitor, and it seeks to dislodge the intruders by asking the cellular neighbors to co-operate in a series of sneezes. Sneeze after sneeze—but the pollen still hangs on and sends its poisoned shafts in all directions through the tissues. The nostrils alternate in closing up, the head stuffs up with pressure from within and eyes seep out their copious emanations. The attack spreads and involves the bronchial and laryngeal tracts, the voice grows thick and echoing and then a midnight cough appears. Itching nose and swollen palate, labored breathing and a hunger for pure air all are symptoms of the attack of the little pollen granules on the sensitive individual, and the attack persists in all its intensity as long as there is pollen in the air.

But at last winter comes, and robs the pollen of its sting—and the poor hay feverite, still not any the worse for wear—looks forward to the coming year supinely hoping that the next attack will be a little lighter than usual.

The hay fever season varies in different sections of our country, depending, of course, upon climatic conditions which govern

the flowering periods of the various hay-fever plants. As a point of interest the following table illustrates these seasonal variations and the pollens of primary importance. (This is incidentally suggested for the hay-fever tourist's blue book.)

New England States.

(Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.)

Eastern States.

(New York, New Jersey, Pennsylvania, Delaware, Maryland, the Virginias.)

Central States.

(Kentucky, Ohio, Indiana, Michigan, Illinois, Wisconsin.)

Name.	*Time of Bloom.* (Hay-fever Season.)
Timothy (Phleum pratense),	June to August
Ragweed (Ambrosia elatior),	August to October

Southern States.

(North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas.)

Name.	*Time of Bloom.* (Hay-fever Season.)
Bermuda grass (Capriola dactylon),	May to September
Timothy (Phleum pratense),	June to August
Johnson Grass (Sorghum halepense),	June to October
Ragweed (Ambrosia elatior),	August to October

Middle Western States.

(Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.)

Rocky Mountain States.

(Montana, Wyoming, Colorado, Utah, Idaho.)

Name.	*Time of Bloom.* (Hay-fever Season.)
Sweet vernal Grass (Anthoxanthum odoratum),	April to July
June Grass (Blue Grass, Poa pratensis),	May to September
Timothy (Phleum pratense),	June to August
Sage Brush (Artemisia tridentata),	July to September
Ragweed (Ambrosia elatior),	August to October
Russian thistle (Salsola pestifer),	July to September

Southwestern States.

(Southwestern Texas, New Mexico, Arizona, Southeastern California.)

Name.	*Time of Bloom.* (Hay-fever Season.)
Cottonwood (Populus macdougali),	February to April
Shad scale (Atriplex canescens),	March to June
Rabbit bush (Franseria deltoidea),	April to May
June Grass, Blue Grass (Poa pratensis),	May to September
Bermuda Grass (Capriola dactylon),	May to September
Johnson Grass (Sorghum halepense),	June to October
Annual Saltbush (Atriplex wrightii),	July to September
Russian Thistle (Salsola pestifer),	July to September
Sage Brush (Artemesia tridentata),	July to September
Careless weed (Amaranthus palmeri),	July to October
Slender Ragweed (Franseria tenuifolia),	September to October

Pacific States.

(Nevada, California, Oregon, Washington.)

Name.	*Time of Bloom.* (Hay-fever Season.)
Black Walnut (Zuglans nigra),	March to May

(In California, this is much grown as a shade and ornamental tree in the Sacramento, Napa and Russian River valleys, where it is the most frequent cause of spring hay fever.)

Orchard Grass (Dactylis glomerata),	April to August

(Apparently orchard grass is one of the most active of grass pollens occurring throughout the State of California, especially in meadows and pastures of the north, and extending through Oregon and Washington.)

Perennial Rye Grass (Lolium perenne),	May to July

(This grass is most important from San Francisco northward, and in Oregon.)

June Grass, Blue Grass (Poa pratensis),	May to September
Bermuda Grass (Capriola dactylon),	May to September
Timothy (Phleum pratense),	June to August

(This is a very important cause of hay fever in the northern and mountain countries of California and in Oregon and Washington.)

Redtop (Agrostis palustris),	June to September
Johnson Grass (Sorghum halepense),	June to October
Russian Thistle (Salsola pestifer),	July to September
Redroot Pigweed (Amaranthus retroflexus),	July to September
Sage Brush (Artemisia tridentata),	July to September
Mugwort (Artemisia vulgaris),	July to October

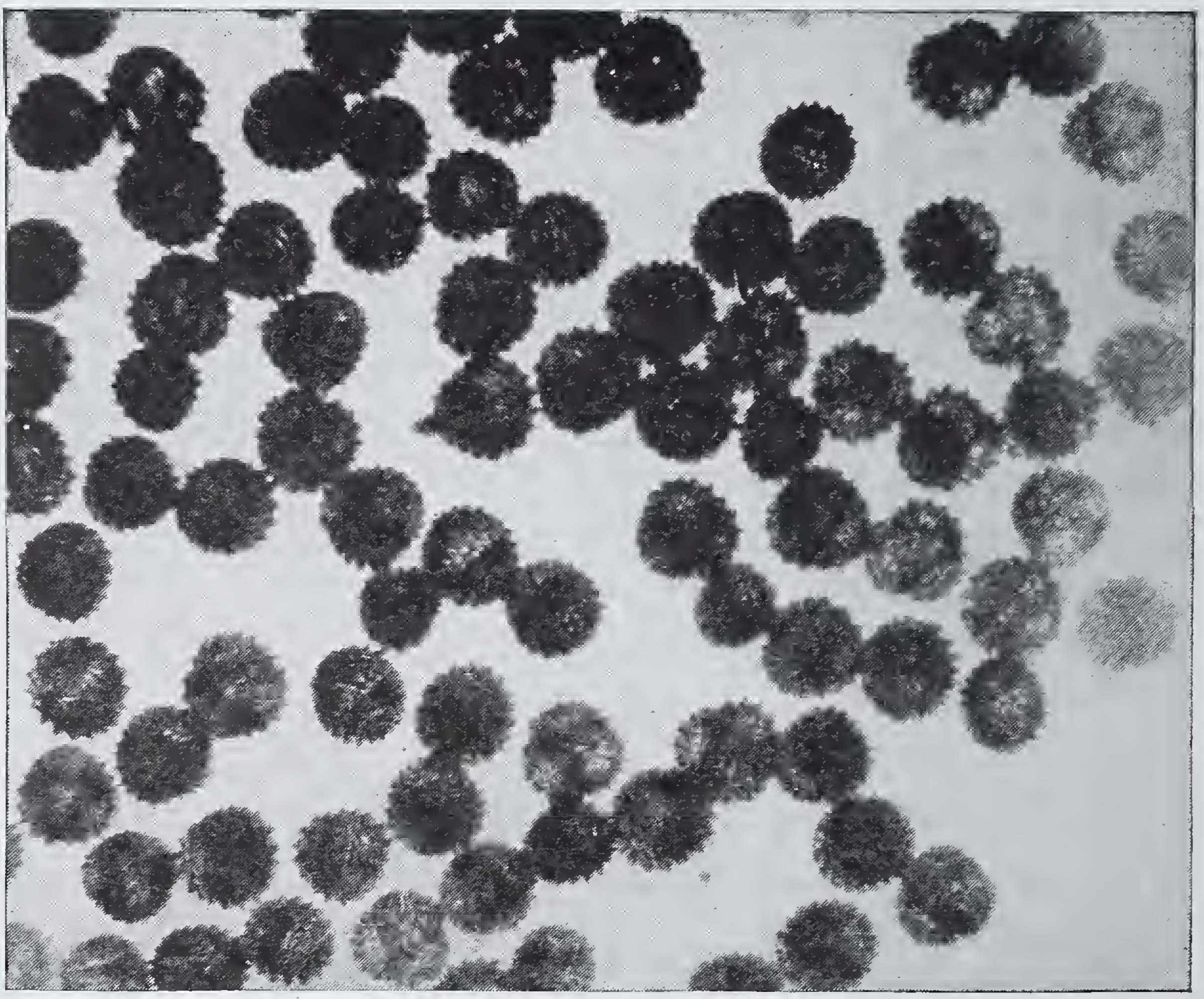
(In California, the mugwort is the most frequent cause of the fall type of hay fever).

(These tables are compiled from a bulletin issued by the Lederle Laboratories.)

Methods for relieving this dread malady have occupied the attention of the medical profession for many decades, and it has become bromidic to remark, "If anyone could invent a cure for hay fever he would certainly make his fortune." But if we believe the times cure, or at least relief, has come.

Of course it was long known that a sojourn in a part of the country where the offending pollen is not in the air, often alleviates the fever. But not all members of the sneezing fraternity can afford to leave their indigenous habitations and emigrate to new surroundings for a large fraction of each year. Then again, high elevations are said to lessen the menace. If this were actually so, a healthy part of our communities would probably migrate to a mountain top or hire a hall in a skyscraper during the pollinating season. This is not practicable and probably not necessary. For now, by means of the remedy known as the immunization pollen treatment, which is of comparatively recent exploitation, it is possible to effect a cure in some instances, and a lessening of the symptoms in a larger ma-

jority of cases. This treatment was conceived by recent medical experimenters and while new in application is not at all novel in concept. A thousand years ago the doctrine of signatures was in vogue. This conceived of the infantile idea—and it existed when our civilization was an infant—that a round drug would cure a round boil—that a dark brown drug would correct a dark brown taste; that a stewed hare would cure baldness, etc. Hahnemann later resurrected the old doctrine, camouflaged it with a little erudition—



POLLEN OF GIANT RAGWEED, Ambrosia trifida.

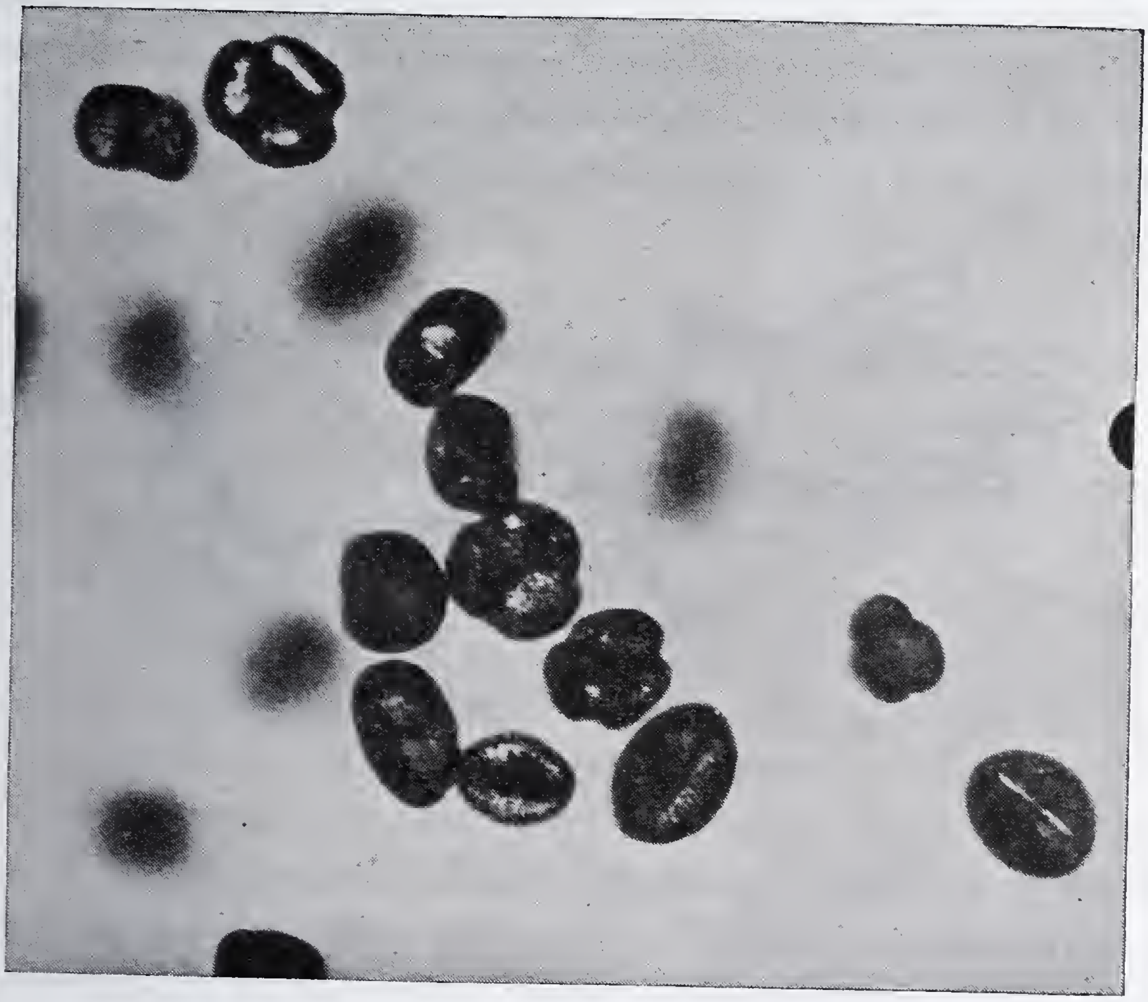
Magnification, Approximately 400 Diameters. The Pollen of the Low Ragweed (Elatior) Differs Only in Size.

called it by the official Latin title—*Similia similibus curantur*—and sold it under the synonym of homœopathy. Then along came the more recent adaptation of the old empiric theory to vaccines, and other immunologic agents. Under its ministration we attempt to cure pneumonia with pneumococci; smallpox with the cowpox virus, and anthrax with the anthrax germ. And so we do with hay fever. We treat it with the pollen or pollens responsible for its causation.

But here, as elsewhere, "If we want rabbit pie we must first catch the rabbit." So to cure the pollen fever we must catch the

culprit pollen or pollens. We must establish the diagnosis. This is done with comparative ease in a great many cases. Others who are sensitive to the rarer pollens require a more painstaking investigation. For, you see, there is a relativity, as Einstein calls it, even to these idiosyncrasies. For instance, there is the story of the young man who was so exceedingly sensitive to grass that he sneezed every time he passed a grass widow.

Before one can catch the culprit pollen it is necessary, of course, to catch the patient. Having manouvered this with skill, the

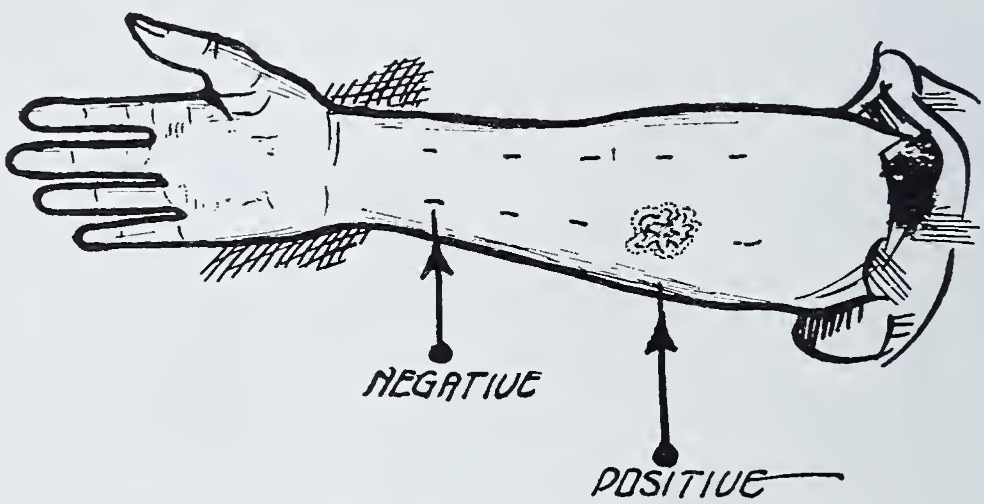


POLLEN OF WORMWOOD, *Artemisia vulgaris.*
Magnification, Approximately 400 Diameters.

next step is to scratch the patient's forearm upon the under side, in several places. This is done with a scarifying instrument and the skillful operator can do so without drawing blood and without hurting the patient or himself. To each scratch, according to a certain prearranged order, there is added a drop of the extract of the various indigenous or local pollens—one variety, of course, to each scratch. The patient will quickly show a local reaction to the pollen to which he is sensitive. An urticarial wheal develops around the site of the scarification, swelling up with great conceit and often

accompanied by a distinct itch. It may develop that the patient is sensitive to a number of pollens, perhaps only to one, and the fewer and less intense the reaction the better chance there is of good results in treatment.

Treatment is instituted generally two or three months before the initial seasonal attack. It consists of administration to the patient by hypodermic injections, of a series of graded doses of the tox-albumins prepared from the pollen or pollens to which the patient displayed sensitiveness. There is a special unit basis of treatment generally conducted which starts the immunization with a very small dose and gradually increases it to a considerable or maximum dose, thus gradually increasing the patient's tolerance. Treatment varies, with the patient, depending upon the latter's reaction, and continues up to the ordinary date of attack, when it is considered



INTERPRETATION OF TEST.

good policy to stop. Some authorities, however, claim that it is wise to maintain treatment during the early attacks of the first season. It is necessary to repeat the treatment annually for the protection afforded is basically transitory. There are people who say that this remedy is worse than the hay fever—that sneezing is a great deal more satisfactory and much more economical than being stuck in the arm with a needle every so often, the intensity of the stick varying according to the seasonal disposition of the sticker and the antiquity of the needle. But the hay feverite who has had good results never says this. He is usually so thankful that he even pays his doctor's bill, promptly and in full.

And now we come to the concluding idiosyncrasy, namely, that which is unknowingly exhibited by a great number of people who

suffer from what is known as asthma. Not all cases of asthma are of this type, of course. Reference is only made to the so-called allergic or protein asthmas. The dreaded symptoms of asthma, a disease rarely fatal but always hideously and distortingly painful to its victim, are only too well known to attempt describing here. Sufficient to state that the disease, like other evil influences, often "flies by night." The sufferer in its cruel grasp is seized at a time when slumber should be his portion. He is generally awakened from a sleep, his breathing labored and difficult. The effort to fill the lungs and expand the diaphragm is very urgent but not at all productive. The victim often struggles for his breath for long and lonely hours. The night is made more hideous by the never ceasing pain. The spasm may continue till the dawn and then subsides, often leaving the patient weak and nervous for the rest of the day. And these terrible attacks recur frequently.

Such asthmas are often caused by the undue sensitiveness of the victim to a foreign protein which has surreptitiously come into the body ramparts, and has by its mere disgusting presence upset the tenor of the rest of the body's cellular population. This foreign protein may be inhaled and absorbed through the mucosa or it may be carried into the stomach, as is the case with the food proteins. In the latter instance even the digestive functions of the gastric region do not seem to neutralize or break down the vicious protein. It is a well-known fact that if we introduce directly into the blood stream of a normal and healthy animal, a small portion of white of egg (which is a simple protein) that animal will immediately show rebellious reactions (known as anaphylactic shock) that may become so uncontrollable as to cause the death of the animal. Medical history is not without notable records of such mishaps with human subjects. Pituitrin, horse serum and similar nitrogenous bodies have been known to kill patients who were antipathic to these bodies and who had not been tested beforehand to assure their reaction.

So it is with persons exhibiting these asthmatic reactions. Frequently the sensitive body may show its chagrin in another way. It may develop a "rash" or urticaria or dermatitis. Diagnosis and treatment of these antipathies are conducted exactly as with hay fever.

The causative factors in these asthmas, skin eruptions and irritations, belong to several groups—vegetable and animal in origin. Among the animal proteins responsible may be mentioned the following agents:

Animal fur, such as cat fur, dog fur, rabbit fur;
Animal dandruff,* horse dandruff, stable dust, etc.
Feathers, from chicken, goose, etc.;
Meat proteins, pork, veal, etc.;
Dust, which contains a conglomeration of things.

Those of vegetable origin are numerous, the cereal proteins, fruit proteins, edible nut proteins, etc.

Then there are the bacterial proteins which often cause more trouble than is generally known. A few interesting cases of authentic record may be given as our final offering.

Case No. 1. A young boy who was a victim of a violent bronchial asthma, and who displayed skin reactions when tested against feathers and egg proteins.

This boy's physician ordered complete extinction from the boy's diet of all fowl-meat and eggs. He was not allowed to sleep on a feather bed or rest upon feather pillows. He was further treated with the protein desensitizing solutions over a three months period. The results were completely gratifying. No chicken—no asthma.

Case No. 2. (From medical literature):

One asthmatic is stated to be so sensitive to egg protein and hen meat that he can eat rooster meat and probably eggs from the same source, with impunity, but hen meat or eggs bring back his malady.

Case No. 3. (From newspaper source):

Mrs. Jones was suing the taxidermist for having sold her an improperly dyed fur coat which caused an unusual skin eruption around the neck and wrists every time the coat was worn. It was

*It might be interesting to note at this point that human dandruff seems to show an uniformly positive reaction when applied to human beings. This fact may explain certain excemas and skin disturbances that often accompany dandruff shedding.

argued by the prosecution that the coat was colored with a poisonous coal tar dye and the dye not properly mordanted or fixed. This leached dye was considered responsible for the skin eruption and general systemic reaction. The taxidermist, however, was able to prove, with the assistance of a physiologic chemist, that the dye was non-poisonous, was properly mordanted and that the reaction was caused by an idiosyncrasy which the wearer exhibited to the squirrel fur of which the coat was constructed. This was very conclusively proven—and to the satisfaction of the Court, by taking a piece of cured squirrel fur and fastening it to the upper arm of the plaintiff, whereupon appeared in due time the typical urticarial rash.

The cuts of pollen granules are generously loaned by the H. K. Mulford Company of Philadelphia.

SOCIAL INSECTS.

By Marin S. Dunn,
Assistant Professor of Botany.

As the subject of Social Insects is at present receiving much public attention and interest, I have felt that there was a demand for a short paper which, in a definite and concise way would touch upon the general anatomy of a typical insect, a short description of the lives and habits of the four great groups of social insects, namely, the social wasps and bees, ants and termites, and an abbreviated discussion of instinct and intelligence.

Insects are those arthropods which possess a pair of variously modified organs called antennæ, three pairs of legs and generally wings in the adult state. They are about us in unsuspected numbers, and should we open our eyes to their existence, they would form an everlasting source of amusement, interest and even profit. In this paper, I briefly propose to outline the antomy of a typical social insect and to take up those societies only in which social life has reached a high state of perfection as in certain families of the *Hymenoptera* and the *Isoptera*. By doing so, I shall be forced to omit certain very interesting insect groups such as the dung-beetles (Fig. 1), certain wasps, etc., that may be described as subsocial.

It is to be noted that each of the societies that will be mentioned is composed of or derived from two parents and that the offspring live with one or both of the parents as the case may be and share to a greater or lesser extent in the duties of making and keeping the home harmonious. The lengthening of the adult life has helped to bring this about since one or both parents may live with their own offspring, providing for them and guarding them, until they have reached a place in their life history where they can assist in the duties of the home.

As has often been brought out, the actions of animals are influenced by three fundamental impulses, namely, hunger, fear and sex. Wheeler [25] has aptly stated "the whole life-cycle may consist of a few appetitive cycles of very elaborate patterns—the so-called 'instincts.'" Among social insects, these fundamental appetities do not disappear but become variously modified to adjust the individual

to its environment. The number of stimuli which affect it must necessarily be greater.

Food is often very scarce, and members of a colony must practice rigid economy. It is not strange that individuals fortunate to find abundant supply not only feed themselves but bring back quantities to the nest where it is apportioned or stored. Specialization of certain members for this work of foraging, feeding and storing has led to a worker caste.

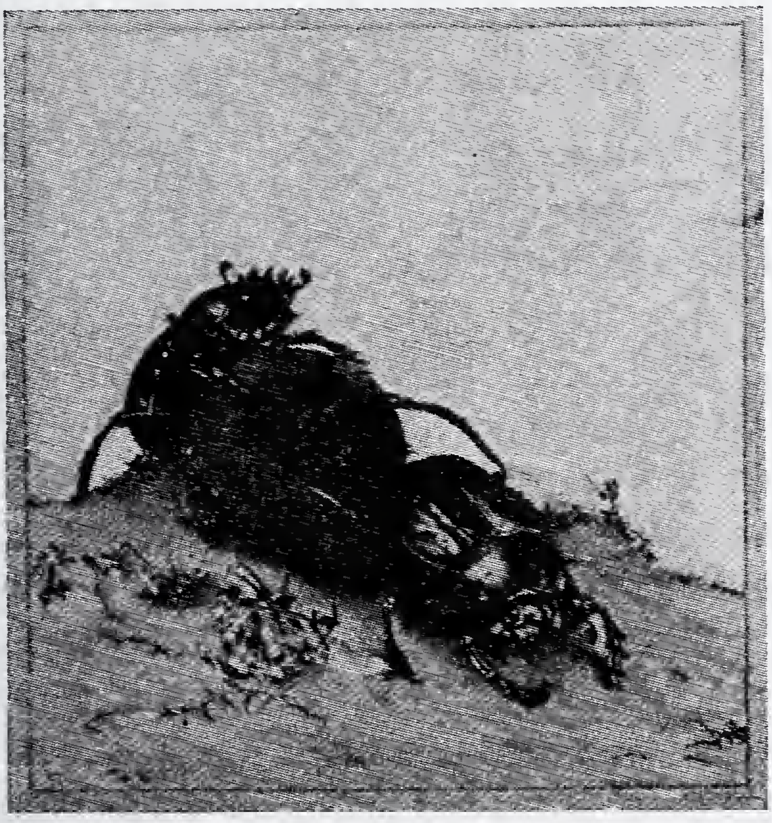


Fig. 1. — Sacred scarabæi (Scarabæus sacer) trundling their pellet of dung. (From W. M. Wheeler, after E. J. Detmold.)

Because of the scarcity of food, the reproductive ability must be limited and modified or the colony may starve through over-population. Hence certain females and males have developed remarkable reproductive propensities while the rest of the colony may be reduced to the state of physiological sterility.

Since the colony must be protected against enemies, certain members have developed large jaws, poisonous secretions and stings with the result that they are better able to defend against intruders. In certain colonies, members of the worker caste assume this function, but among certain ants and termites, this specialization has led to a soldier caste.

Therefore, as an outcome of these basic appetites, there arise the different castes, specialized in their own way, of the colony of highly organized social insects.

It is necessary before proceeding to the actual discussion of the four groups of social insects that we shall review in this paper, to understand the general anatomy of a typical member of one of these groups. And what could be more fitting than choosing for our example that friend of man whose name has been linked with the human race for centuries—the honey-bee?

Anatomy of Honey-Bee.

The chitinous body of the honey-bee may be divided into three regions, the *head, thorax* and *abdomen.* The *head* possesses two compound eyes, three simple eyes or ocelli, two antennæ and the various parts of the mouth. The mouth parts are as follows: An upper lip called the labrum from beneath which projects the epipharynx, the jaws called mandibles, one on either side of the labrum, the two maxillae or under jaws, the labium or under lip extending downward from beneath the labrum and a hairy tongue or ligula which is long and flexible having a spoon or bouton at its tip. Both maxillæ and labium possess jointed structures, known as maxillary and labial palps respectively. The maxillæ and labial palpi are so arranged that enclosing the tongue they form a tube which is completed at its upper end by the epipharynx fitting into the space between the jaws. The mandibles work in a transverse plane, being controlled by powerful muscles.

The three-segmented *thorax* is covered by flexible pollen-collecting hairs. In addition, the *thorax* bears three pairs of legs, one pair per segment and two pairs of wings which are situated on the middle segment (mesothorax) and posterior segment (metathorax). The legs are composed of the following regions beginning at the end nearest the body: the coxa, or hip; the trochanter; the femur, or thigh; the tibia, or shank; and the five-jointed tarsus, or foot, ending in strong claws. The membranous wings, supported by ribs or veins are held together on each side of the body, presenting a solid sheet for flight, by small hooks on the forward margin of the hind wing which fit into a fold in the rear margin of the front wing.

The *abdomen* is made up of six segments, seven in the male, connected by thin membranes of chitin. Wax glands are here present. The queen and worker possess at the end of the abdomen a

sting which is a complex structure composed of two ten-barbed darts, and a sheath. Once a suitable place has been selected by means of a pair of palps, the channeled sheath serves to guide the darts, to conduct poison and to pierce the object to be stung. The grooved darts move upon two guide rails fixed upon the sheath. After the sheath has caused a wound, the darts strike alternately, and the sheath itself may plunge in deeper. Two glands, one acid and the other alkaline, secrete the poison which is stored in a reservoir and by means of a duct enters the sheath channel where it is directed into the wound. In stinging, a part of the intestine may be pulled out, so that death resulting is merely a matter of time.

The *digestive* system is composed of a mouth, salivary glands, an œsophagus, a honey sac situated near the forward end of the abdomen, a stomach, the intestine, where digestion and absorption are completed, and an anus.

At the union place of stomach and intestine are long tubes (Malpighian tubules) which are *excretory* in function, pouring their contents into the intestine.

Blood is contained in the dorsal heart which acts as the chief circulatory vessel. In this vessel, the flow is forward, and from the head, the blood passes through spaces to the under surface of the body and back again to the heart.

Respiration is accomplished by seven pairs of openings known as spiracles, situated on the sides of the body, which in turn open into tracheæ or air-carrying tubes which branch repeatedly, and even in certain places are enlarged to form air sacs. It should be noted that oxygen here is carried directly to parts of the tissues needing it.

The *brain* is situated in the upper part of the head, and this is connected by nerves with the eyes, labrum, antennæ, as well as with a ganglion directly beneath the œsophagus. This ganglion supplies the rest of the mouth parts. From it there extends along the ventral part of the body a nerve cord with a series of ganglia.

The *sexes* are distinct, the females (queens) possessing large functional ovaries, the workers undeveloped ovaries (and hence, female) and the drones or males functional testes.

Spermatozoa are stored during the act of mating in a special receptacle in the body of the female, where they may live for varying lengths of time.

Social Wasps.

Without taking into account the solitary wasps, we shall at once proceed to the true social wasps of the family *Vespidæ*. The two genera that are present in the United States (if we except *Polybia*, a California genus) are *Polistes* and *Vespa* with certain species.

Polistes: Polistes is a handsome wasp with a spindle-shaped abdomen, in color black with yellowish rings or brownish. The colonies consist of three forms of individuals, female, workers and males. Since, with the approach of cold weather, the males and workers die, we may say that in our clime the colony is an annual affair. With the advent of spring, a single fertilized queen which has been hiding in the sundry cracks and fissures of walls or under the bark of trees, starts to build her home, lays her eggs, and brings food to the developing young. These, when fully developed, aid their mother in enlarging the nest, caring for the next brood and in obtaining food. As more and more workers are produced, the number of laborers becomes greater, and the queen is not taxed as severely, and food becomes more plentiful. The larvæ, appearing later in the summer, are more copiously fed, and as a result males and fertile young queens arise in larger cells especially made for them. The workers at this time may lay eggs, but these are said to produce only males. Mating occurs and the fertilized queen crawls away for her winter rest.

Home.—Although we think of *Polistes* as associated with barns, sheds and lofts, their nests are often built on trees and bushes. The nest, itself, is composed of paper obtained by mixing fragments of woody tissue, stripped from logs, trees, etc., with a cementing fluid which glues the fibers together. The jaws play their part in this process. A single layer of hexagonal cells, directed vertically or even horizontally, forms the comb, and this is attached to or hangs from a convenient support. A paper envelope is not present. The Raus [20] have found that certain old nests of *Polistes* may have a number of queens upon them and there is reason to believe that these nests are used again and by more than one queen. Of course, the eggs, at the proper time, are laid in the comb. As a rule, the colony is not very populous, but the nests of *P. annularis* sometimes attain the size of over a thousand cells.

Feeding.—The larvæ are fed at first by regurgitated nectar, but later with small, chewed portions of caterpillars, flies, etc., by the workers and queens. Dr. Wheeler[25] states "the hungry larvæ protrude their heads with open mouths from the orifices of the cells like so many nestling birds." However, the feeders receive their reward by sucking eagerly the little droplets of saliva which the larva emits from its mouth. Here, therefore, is a mutual exchange of food. This beverage is enjoyed also by the males, and they eagerly may seek it without bringing or giving any food. Perhaps the care and solicitude of the colony for its larvæ is partially explained on this somewhat selfish basis.

Homing.—It has been noticed by many scientists that certain wasps seem to have a remarkable power of finding their way home even when carried to a relatively long distance, in the absence of light and with every effort made to confuse them. Some investigators have thus, accepting the facts, attempted to explain this homing by granting an unknown or mysterious sense. The Raus[20] in working with *Polistes pallipes* in a careful set of experiments covering certain phases neglected by most observers, namely, the age, experience and sex of the subjects, together with permanent identification markings without injury, find no traces of an unknown force and conclude that the factors, age, experience, memory and perseverance bring the *Polistes pallipes* back to their home.

Newly-hatched workers, if removed only a short distance from the nest, could not find their way back, while those members that had a chance to explore and make orientation and food flights, if in good health, could return without great apparent trouble even from a distance by their remarkable memory of landmarks.

Vespa: The members of this genus represent our typical social wasps. Nearly all of us have seen the pendant grayish bags hanging from limbs of trees, and have avoided them conscientiously because we sadly realize the valor and the weapons of their inhabitants (*V. maculata,* the bald-faced hornet).

At one time, this large nest was started by a single queen and was only a small hanging comb covered by a papery envelope. As the nest grew and the eggs developed, the comb and its contents were enlarged, the inner layers of the envelope were removed, re-chewed by the wasps and carried to the external parts. Later

an additional comb was built, hanging by slender stalks, below the first. In this way, the nest expanded, keeping pace with the size of its combs and the number of its inhabitants.

Another species of *Vespa* (*V. germanica*) forms its home beneath stones or in holes in the ground. Usually, there is one entrance. In the matter of food, the Raus found this form to be practically omnivorous, eating grapes, peas, paw-paw and even parts of dead rodents.

Parasitic Members: There are two parasitic species of *Vespa* (*V. austriaca* and *V. rufa*) represented only by fertile females and males. It has been demonstrated that *V. austriaca* lives in the nests of the common yellow-jacket (*V. diabolica*). Probably its parasitic habits have been acquired and since its young are cared for by their hosts' workers, there is no need for a worker caste.

The Peckhams,[19] experimenting with colored papers, found that changes in color were detected by the *Vespas*.

We shall have nothing to say in this paper concerning the three sub-families—the Australian *Stenogastrinæ,* the tropical *Rhopalidinæ,* and the *Epiponinæ* of tropical America. Readers who are interested in these groups will find Dr. Wheeler's "Social Life Among the Insects" an invaluable help. To this work, I refer them.

Bees.

Broadly speaking, bees are merely a group of wasps feeding on nectar (rich in sugar) and pollen (rich in proteins and oils). Nectar is carried, after being sucked up by the mouth parts previously described, in the muscular crop and later, by contraction of the muscles, regurgitated. This regurgitated nectar is called honey, and we find that chemical changes have taken place, induced by ferments, the sucrose being converted into dextrose or levulose.

Pollen is carried by plumose hairs and especially by modified leg areas which will be later described. Many bees are solitary and it is only in the *Bombinæ* (Bumble-bees), *Apinæ* (Honey-bees), and the *Meliponinæ* or stingless bees, which we shall not consider in this paper, that we know true social life in its highest form.

Bombus: The bumble-bee, active and industrious as any of its relations, is found in North America, Central Asia, Europe, Britain, and in certain tropical lands, especially on the sides of

mountains. Sladen [21] states that they are found from 2000 to 12,000 feet in the Himalayas. Their general colors are black, white, yellow and ferruginous. Because of their long, hairy, grooved tongues, they can effectively visit the red clover. In fact, *B. terrestris* and *B. ruderatus* were sent to New Zealand in 1884 to assist in the pollination of this plant, which had not been up to that time seeding freely.

Sladen [21] states as an explanation of the buzzing sound produced by these bees, that "the spiracles of the thorax, which are situated under the wings, contain a vocal apparatus which is the source of the buzzing sound made by the humble-bee when it is irritated. Just inside the spiracle the windpipe is enlarged to form a sounding-box, and the sound is produced by the air expired passing over the edge of a curtain-like membrane fixed across the mouth of the sounding-box."

Life History.—Let us now trace the life history of a single colony, which at our latitude is annual. A single fertilized queen winters over and in spring starts her nest in a log or small hole in the ground devoid of inhabitants. After she is sure that she is satisfied with her choice, she places a little compact lump of pollen mixed with honey on the floor, and builds a circular waxen railing on its top. Inside the enclosure, her first eggs are laid and covered with wax. A small honey pot is built near the nest opening, and in this is kept the honey which will serve as food for the queen in inclement weather. The female sits on her eggs to keep them warm and in about four days they hatch. The larvæ begin to eat the lump upon which they find themselves, and the queen must constantly add new material to the lump, feed the larvæ and add wax to keep them hidden. About the eleventh day, the larvæ spin their cocoons, and they are so arranged that they can advantageously receive the warmth of the queen, who sits upon them, facing the honey pot. The emerging workers are smaller than their mother, and take up the work of the colony. Later workers are larger. The now increasing flow of pollen and honey is stored in special vessels or even in old, empty cocoons. Through abundant feeding, queens and males are produced in late summer. After fertilization, the queens leave, and those living over the winter start new colonies in the spring.

Howard [15] in his "Insect Book" tells us how bumble-bees may be entrapped by a jug of water standing in close vicinity to the

nest, which lures the bees after they are stirred up, by reason of the air set in motion by their wings, giving an "answering roar to their angry humming."

Parasitic Forms.—Psithyrus, a closely related form, is called the Usurper-Bee, and breeds in the nest of its particular species of *Bombus.* Like the parasitic *Vespas,* no workers are produced. These bees have a thick skin and the abdominal segments lap tightly. Is it any wonder, then, that although for a time the *Psithyrus* queen seems to live in peace within the *Bombus* colony, that she may, after enraging the *Bombus* queen by laying her eggs, become a deadly parasite, killing her hosts' queen and making the *Bombus* workers rear her young? Sladen [21] describes a nest of *B. hortorum* containing its parasite, *Ps. barbutellus,* in which there were 49 *hortorum* workers, 16 young *barbutellus* queens, 2 small *barbutellus* males, and the body of the old *barbutellus* queen. The brood consisted of 38 *Ps.* cocoons containing pupæ, chiefly queens, and a cluster of 5 *hortorum* cocoons containing pupæ developing into males, and also a few larvæ and eggs.

In addition, the bumble-bee is forced to guard itself against flies, mites, badgers, moles, weasels, field mice, etc.

Honey-Bee: The history of the honey-bee has been linked with that of the human race. It has been utilized by man for hundreds of years as a source of sugar. Wheeler [25] states: "They figure on the Egyptian monuments as far back as 3500 B. C., and we even know the price of strained honey under some of the Pharaohs. It was very cheap—only about five cents a quart." On account of their peculiar habits, their industry and devotion, they were given special attention and numerous myths and superstitions grew up concerning them.

The *Apis* colony is composed of queens, drones and workers. The workers are females whose reproductive organs are atrophied. The queen, herself, is only an animated egg-laying machine with the power, it seems, to lay either fertilized or unfertilized eggs. It is from the drone that the spermatozoa arise which are stored in the body of the queen in a special sac called the spermatheca. Queens and workers arise from fertilized eggs, while unfertilized eggs give rise to drones. The comb is of wax, produced by glands situated between the abdominal segments.

Comb-Building.—Let us imagine an old-fashioned uninhabited hive into which a crowd of bees is beginning to pour. They crawl up the walls and cling to one another, forming long festoons. Cheshire [3] finds that the remarkable ability of the bees to suspend themselves from their companions and at the same time to support the weight of the bees clinging to them is due to the strong claws which are present at the end of the tarsus. Heat is generated and little waxen flakes on the under side of the abdomen become apparent. A single worker transfers these flakes to her mouth and chews them, at the same time secreting a fluid which makes them plastic, and attaches to the roof the plastic wax. Her comrades do likewise and soon a pendant wall of wax is formed. Little depressions are chewed out on both sides of this wall, and these are the bottoms of the comb cells. The wax which has been chewed away is used in making the sides of the cells. Thus we see in the finished comb a midrib with hexagonal prismatic cells on either side so formed that the bottom of the cells on one side alternate with the bottoms of those on the other side. For a full description of this process the reader is referred to Cheshire's admirable work. An exudation known as propolis, obtained from the poplar, horse chestnut and other trees, is used in filling the chinks and sometimes on the edges of the cells. The cells which are to produce workers are smaller than the queen cells and drone cells.

Life History.—The eggs are laid by the queen, one in each cell, and later develop into the footless larvæ, which are fed by certain workers called nurses with a pharyngeal secretion called "royal jelly," rich in proteins. After the fourth day, pollen and honey form the food of the future workers. Later the larva spins a cocoon, and remains in the cell, previously capped by wax and pollen, until it finally emerges as an adult about twenty-one days after the laying of the egg.

The first duties of the young worker is that of nurse, and she must to elaborate food for the larvæ have access to cells in which pollen and honey are stored by the forager workers. As soon as her usefulness in this line has disappeared, she takes an initial flight, orients herself and becomes one of the many searchers of food.

The queen cells are much larger than the worker and drone cells and hang vertically. Royal jelly only forms the queen's diet and she emerges in about sixteen days.

In time, the extreme fertility of the queen would lead to over-population unless some means be taken to prevent it. A new queen is reared by the workers in a queen cell, and the old queen usually collects a cohort about her and seeks a new home, leaving the old one to the surviving new queen. This is called swarming. It is to be noted that by this method not only are new colonies formed, but the bees actually increase the number of their colonies. The new queen, upon mating with a drone, carries forth the production of eggs in the old colony. There is a saying to the effect that swarming bees will not sting. In fact, there is a case on record * where a queen, accompanied by her followers, alighted on the head of a boy. The child, directed by his father, did not move, but allowed his father to pour water over his head, bend it forward and stroke the bees into a basket. The boy was not stung.

The nectar of flowers is sucked up by the tongue previously described, stored in the honey sac and later placed in open cells, where much of the water it contains is evaporated by the currents of air produced by certain workers engaged in vibrating their wings, and thus ventilating the hive. The honey is stored conveniently above and around the brood nest in cells which are closed by porous caps of wax.

Nectar Plants.—Different flowers produce different kinds of nectar, and hence the taste of the honey produced is dependent on its source. Plant lice (*Aphids*) produce an inferior kind of secretion in great abundance, obtained from the juices of the various plants on which they live. Bees may feed upon this, and the quality of their honey thus be injured because of its source. Certain plants also produce nectar which is poisonous to the human, as, for example, the honey obtained from the *Kalmia latifolia.* Other plants offer bees a source of nectar which they use for elaborating most palatable honey. Among these, I mention the clover, the knotted figwort, the buckwheat and various members of the mint family, as thyme, sage, etc. It would take a paper many times as long as this to describe the curious flower forms to insure pollination and the methods by which bees obtain their nectar. It would also take another long paper to praise the bee as a fruit setter.

Pollen Collection.—It is not my intention here to discuss in detail the manner by which the honey-bee worker collects and car-

*Deutscher Bienenfreund, 1894.

ries its pollen. Folsom,[8] Cheshire[3] and many others give a lengthy description. Sufficient is it to say that the pollen of plants collected on the branching hairs of thorax, abdomen and leg bases may finally reach the inner surface of each hind metatarsus and is then transferred to the pollen basket or corbicula located on the outer surface of each hind tibia. The pollen from each metatarsus is lodged in the corbicula of the opposite leg.

In connection with the legs, it is necessary also to notice the antennal cleaner of the front legs. This is practically a comb through which the antennæ are drawn and freed from clinging particles.

Odor.—Dr. von Buttel-Reepen[28] believes that the so-called hive odor may be composed of all or some of the following odors: The individual odor, the brood odor, the family odor, the wax odor, the drone odor, and the honey odor. He also believes that bees may communicate by sound, for if a queen be taken away from a colony, the loss may not be missed for an hour or so. But *suddenly,* the humming gives away to a disquieted buzzing. It seems, since the change is sudden, that sound rather than absence of odor conveys this information.

Ants.

True ants are entirely social. We can trace them in the writings back through history, and we find many interesting stories concerning them. Wheeler[25] states that the number of ant species described is about 3500, of world-wide distribution, without including sub-species and varieties. We find their nests in the soil, or even in trees and bushes. Their terrestrial habits have led to extreme adaptability in the structure of the nest, which consists of hollow galleries and chambers and in the care of their young. Their food, too, is varied.

Castes.—There are in the colony three principal kinds of individuals—workers, males and females. In certain species (Fig. 2) several types of workers have arisen, varying from individuals with large heads, who may act as soldiers, or, by well-developed jaws, as grinding mills for seeds, to smaller forms which perform such offices as foragers, nurses and cultivators. Some species have two distinct forms of queens and males. There are many varia-

tions in the relative size of individuals belonging to the different colonies.

Life History.—A fertilized female after her marriage flight comes to earth, breaks off her wings and finds a hole suitable for her nest. She then begins, after a time, to lay her eggs, feeds her legless larvæ, and they finally develop into small workers. These workers then take up the active work of providing food and caring

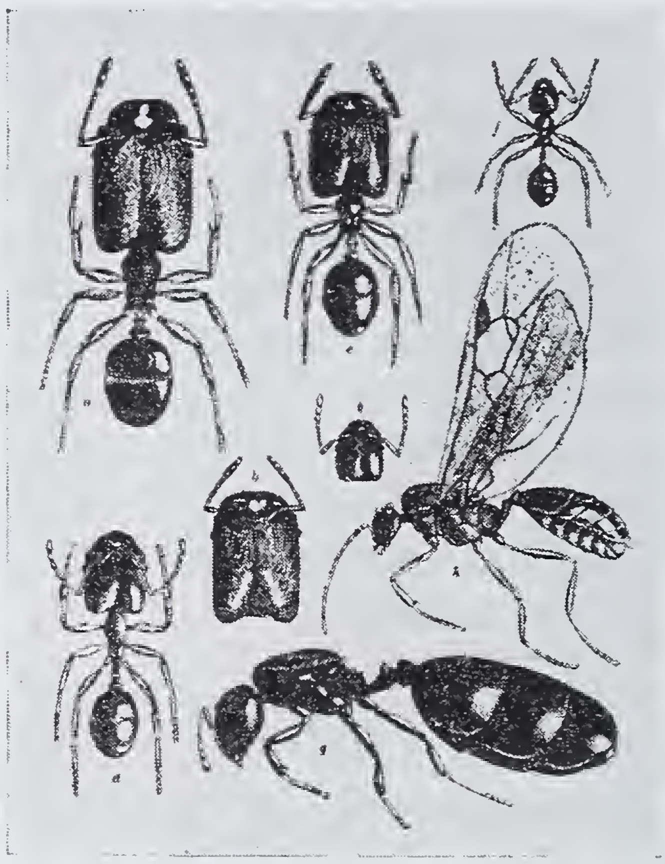


Fig. 2.—A small Myrmicine harvesting ant of Texas, Pheidole instabilis, with polymorphic worker caste. a, soldier; f, worker; b to e, forms intermediate between the soldier and worker (lacking in most other species of the huge genus Pheidole); g, queen (deälated); h, male. The figures are all drawn to the same scale. (After W. M. Wheeler.)

for the next batch of eggs. In species having more than one form of worker, the next emerged are larger. As in the case of the wasps, mutual feeding occurs. The nest spreads until it frequently forms a complex system of passageways, containing many thousands of inhabitants. As time goes on, males and females appear, which at a favorable time make their mating flight.

Ants present many fascinating problems and volumes have been written concerning them. The scope not only involves the

life of a single colony but the interrelations of different colonies, as well as the interrelationship with various insects such as aphids, beetles, etc.

Leaf-Cutting Ants: We have all heard of the activities of the leaf-cutting ants of the American tropics. These ants live in underground nests, and at certain times emerge in great numbers to obtain supplies of leaves and even some flowers. Arriving at the scene of their activity, they climb the plant and bite out portions of the leaves. The portions are then brought home by many columns.

Fig. 3.—Nest of the Texan leaf-cutting ant (Atta texana) at Victoria, Texas. (From W. M. Wheeler, after a photograph by S. J. Hunter.)

Belt * has found that these leaves are used for cultivating a fungus which the ant uses for food. Various species of ants cultivate various kinds of fungi.

Honey-Ants: Certain ants are known as honey-ants because members of the worker caste have given up foraging and have become living receptacles for nectar (Fig. 4). We owe much to H. C. McCook[17] for the knowledge of the interesting habits of *Myrmecocystus melliger* of New Mexico and southern Colorado. He gives the following interesting description: "Within a dome-

*Belt, T.: Naturalist in Nicaragua. J. Murray, London, 1874.

roofed vault, about three inches in width and three-fourths to one inch in height, hung the honey-bearers, clinging by their feet to the roof. Their yellow bodies stretched along the ceiling, but the rotund abdomens hung down, almost perfect globules of transparent tissue, through which the amber-colored honey showed." The honey itself, obtained from certain galls, has been used by the Indians and Mexicans for food and for application to bruises and swollen limbs.

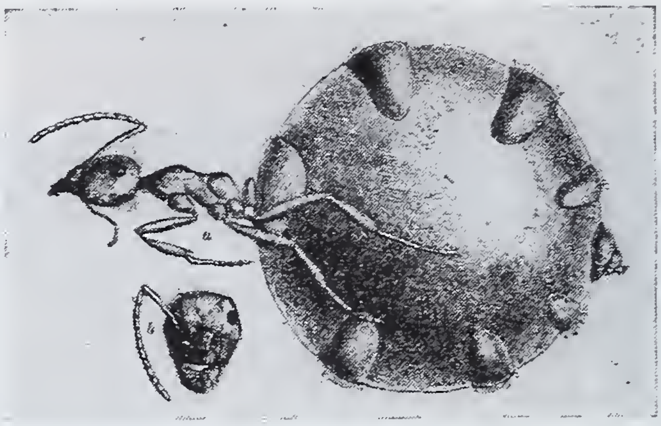


Fig. 4.—Replete of honey-ant (Myrmecocystus melliger) from Mexico, a lateral aspect of insect; b, head from above. (After W. M. Wheeler.)

Harvesting Ants: The same writer[18] has studied the so-called Texan harvesting ants (*Pogonomyrmex barbatus*), which collect seeds of certain grasses and carry them to their nests, where they store them. Dr. Wheeler[25] states: "The harvesting ants can hardly be regarded as true agriculturists, because they neither sow nor cultivate the plants from which they obtain the seeds." Other genera as well as *Pogonomyrmex* belong to this category.

Hunters: Some species are hunters. The blind *Anommas* of Africa are the fear of all they encounter and will even destroy larger animals if helpless. In Brazil, the *Eciton,* as described by Bates,* hunt in large columns which move forward, sending off foraging columns which later re-enter the main army.

Slavemakers: Some ants will enslave other species and we have a series of partial to absolute dependence of the robbers. *Formica sanguinea* enslaves *F. fusca* by kidnapping its larvæ and pupæ,

*Bates, H. W.: The Naturalist on the River Amazons. J. Murray, London, 1863.

which later rear the young of the *sanguinea*. Fabre [6] describes the activities of the slave-hunting Amazon-*Polyergus rufescens*. Brave as a warrior and developed for war, it would find it hard to rear a colony of its own were it not for the captured future workers.

Ants appear to recognize members of their own colony by their odor, but usually display hostility toward other ants.

Memory: Fabre [6] carried out certain experiments (the sweeping of the trail of an ant column before it had returned, the forming of an artificial torrent over which it must pass, the rubbing of mint leaves over the trail, etc.) with the Amazon (*Polyergus rufescens*) which seem to indicate that an ant, at least of the species he worked on, returns home aided by sight and a correct memory of places. An ant placed in a strange locality could not find its way back to the column even though a few feet away.

Can ants communicate with one another? Many investigators believe it. For example, ants have been observed to apprise other members of the colony of a discovered supply of food by means of touching them with their antennæ.

Ant Plants: Since ants are so numerous and so hungry, we would naturally expect to find them eagerly seeking the nectar of flowers, driving away bees and even causing pollen waste. Plants may be protected against ravages of ants, as Lubbock [16] has shown, by water seals, slippery surfaces, the crowding of certain floral parts, the presence of long, downwardly pointed hairs, and by viscid secretions. However, certain plants, as the *Acacia Sphaerocephala, Cecropia adenopus,* etc., are known as ant plants, affording the ants board and lodging while they themselves are protected by the ants against other insect enemies. This relationship, however, is probably one of chance rather than intention.

Other animals, such as crustaceans, spiders, aphids, certain beetles (*Lomechusa*), mites, nematodes, etc., may also be present in an ant colony, thus complicating the manner of life in a single nest, the strangers playing, according to their kind, the various roles of intruders, parasites, visitors, guests and captives.

It is known that many ants make use of aphids because of their secretions. They may even collect aphid eggs, tend them over winter and in spring carry them to their proper plant. Forbes [9] has thus found that eggs of the corn-root louse (*Aphis maidiradicis*)

are cared for by members of the genus *Lasius*. This, it appears to me, is a fertile field for future research work, as many aphids producing plant disease may be harbored in this way. Great and perplexing problems are presented in even a single nest of ants—a new realm to be explored and understood.

Termites.

Termites, or white ants, belong to the Order *Isoptera,* far removed from a taxonomic viewpoint from the insects we have just reviewed. It is therefore interesting to find that they, like the ants which they superficially resemble, live in colonies, whose social life is fully as complex as that of the ants. Like the ants, they are terrestrial, dwelling in elaborate earthen labyrinths, and of course they are subject to the tendencies to certain modifications that hypogeal animals exhibit with various degrees of specialization in the various genera.

Castes.—In contrast to ants, the male in the termite colony is just as important as the female, and we find that the different castes are composed of members of each sex. The sterile, wingless, blind workers are either male or female, and the same applies to the wingless, large-headed soldiers. In the case of the soldiers, the mandibles often are well-developed, or the head is sometimes prolonged into a beak, giving rise to the curious nasutus form. The adults have been divided into three forms—the first, the true kings and queens; the second forms, with poorly developed wings and smaller reproductive organs than the first forms, and the third form, without wings and smaller reproductive organs than the second forms.

Life History.—The winged, dark-colored kings and queens at a favorable time leave the nest and fly into the air and distribute themselves over the surrounding country. They alight and pairing occurs, or they may be found by workers from the old nest and then start a new colony. Each pair digs a small hole, which is the start of the future nest. The queen is the mother of her rapidly increasing brood. Folsom [8] states: "The prolificacy of the queen is astonishing; she can lay thousands of eggs, sometimes at the rate of sixty per minute." The various castes peculiar to the colony appear and take up their life work (Fig. 5).

Heath [13] states that the soldiers of the Californian colonies he studied are nearly always at peace with their fellows. It seems also that these large-jawed members may act as menaces by their appearance.

The females of certain African species possess immense abdomens distended with eggs, and even attain the size of a potato. The eggs hatch into small six-legged individuals.

Nests.—As the colony grows, so the nest may grow. Unlike the many tropical forms which construct huge mounds, our native species burrow in wood and earth and possess no permanent royal cell. Many tropical and sub-tropical forms have characteristic types of architecture. We find nests varying in shape from those sus-

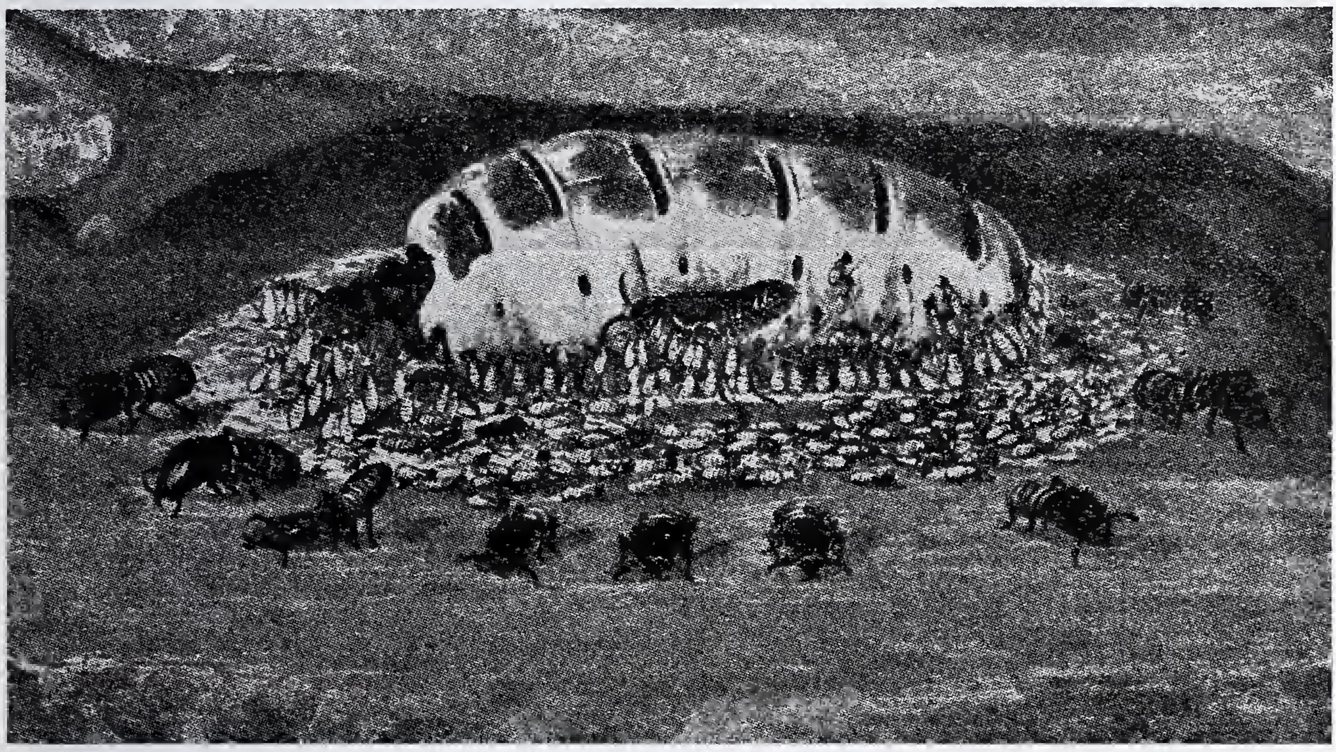


Fig. 5.—Scene in the royal chamber of the African Termes bellicosus, showing the king, physogastric queen and the attendant soldiers and workers. (From W. M. Wheeler, from a water-color drawing by G. Kunze, after Prof. Karl Escherich.)

pended in trees to large, covered, grassy mounds, to erect, wedge-shaped or meridional nests, to pyramids and finally to mushroom-shaped forms. The building material is earth and wood which has been treated to the action of secretions during its stay in the digestive tract.

Fungus-growers.—Certain genera may be compared with the ants of the *Attiini* in their role as fungus-cultivators. In the nest chambers of these species there are balls of vegetable material that have passed through the digestive tracts of the workers. Upon these

the fungus is grown. The young termites are found in these gardens, where they feed upon the fungus.

Damage.—Our native termites may dwell in wood, or live in the ground and indirectly infect wood which comes in their pathway. On account of their inappeasable desire for cellulose, termites have done damage, especially in parts of the South. They attack and eat the timbers of buildings, leaving only a hollow frame. In this way, they are a menace, since supporting structures, as rafters, floors and even furniture are apt suddenly to collapse.

Fig. 6.—Book from the Library at Van Buren, Arkansas, ruined by termites. (From W. M. Wheeler, after Thos. E. Snyder.)

Banks and Snyder[1] give as some illustrations the damage to the old building of the Bureau of Engraving and Printing in Washington, a hospital in Jersey City, New Jersey; a railroad station in Baltimore, Maryland, and even churches in Washington, etc.

They attack and destroy books (Fig. 6), telegraph poles, bridges, ships, railroad ties, and damage cotton bales and even injure certain fruit trees by girdling them below the ground level. In the tropics, the termite activities are far more pronounced, and in certain places they are held in dread on account of the amount of destruction they can accomplish.

In addition, termites have formed the habits of mutual feeding with both regurgitated food fæces, saliva and with individual exudations.

It has been shown that swarming may occur with the development of certain trees. *R. flavipes, Kollar,* swarms with the ripening of pollen of the *Cornu's florida; R. virginicus,* at Washington, about a month later, after the mountain laurel (*Kalmia latifolia*) and the chinquapin (*Castanea pumila*) are in full bloom.

To add to the complexity of their life, termites are preyed upon by flies, lizards, spiders, centipedes, birds and even man himself. Folsom [8] states that "the hill-tribes of India are accustomed to eat the termites themselves, the flavor of which is said to be delicious." The problem of the relations existing between termites and those insects which live in their nests (termitophiles) offers opportunity for very attractive study.

Instincts and Intelligence.

Naturally, since we have now considered briefly the life-habits of certain social insects, and have to a degree peeked and pried into their home-life, we ask ourselves whether their actions are simply due to the following of unbending, iron-clad reflexes, or to an actual share of intelligence which permits of more or less conscious actions that experiences may mould. Are these insects merely bits of protoplasm responding to various fundamental stimuli which greet them on all sides, without the use or command of any judgment or choice? Or may the smallest hymenopteran at times of its volition by the use of its tiny brain exercise the right of choice and do something utterly unknown before in the history of its kind?

The Peckhams [19] have included under the term "instinct" those complex acts which are performed previous to experience and in a similar manner by all members of the same sex and race, leaving out as non-essential, at this time, the question of whether they are or are not accompanied by consciousness. Undoubtedly, in this category belong most of the actions of the insect. Stinging, hunting certain prey, nest-building, and in fact most of the acts of insects are purely instinctive. Fabre,[6] concerning his experiments on the nest-building of the mason bee, says: "If anyone sees a rudiment of reason in this *Hymenopteran* intelligence, he has eyes that are more penetrating than mine. I see nothing in all this but an invincible persistence in the act once begun. The cogs have gripped, and

the rest of the wheels must follow. The mandibles are fastened on the pellet of mortar; and the idea, the wish to unfasten them will never occur to the insect until the pellet has fulfilled its purpose. And here is a still greater absurdity: the plugging once begun is very carefully finished with fresh relays of mortar! Exquisite attention is paid to a closing-up which is henceforth useless; no attention at all to the dangerous beam. O little gleams of reason that are said to enlighten the animal, you are very near the darkness, you are naught!" Once an insect performs a reflex act, this may in itself call for another, and a chain of reflexes result.

However, it appears that reflex actions may be subject to slight variations. There may be variations in holding prey and in the egg-laying and provisioning of the nest. The Raus,[20] in observing *Pompiloides marginatus,* found that this wasp walked backwards with a spider, holding it in a vertical position, with the mandibles inserted in the ventral surface between the legs, while another member grasped a spider by one coxa. It may be true that advantageous variations tend to establish themselves to the exclusion of those which are harmful. The latter in time disappear.

However, we cannot account for certain actions on the basis of pure instinct. Howard[15] relates the following story of some medium-sized black ants which were attracted by the presence of plant lice and mealy bugs upon hothouse plants: "A number of years ago some Liberian coffee-trees were started in the greenhouse. On the under side of the leaves of these coffee-trees, there exist at the bases of certain of the leaf ribs some very minute, nectar-secreting glands. The ants soon found this out and sipped the nectar. Then the idea occurred to some clever ant that these nectar glands would be the best places in the world for mealy bugs to live and grow fat and they would in consequence secrete a great deal more nectar than they would if they lived on other parts of the leaf. But the nectar glands were too small to accommodate even one good-sized mealy bug. So the word was passed around and the ants gnawed the edges of the gland and enlarged it so that it would accommodate a good-sized mealy bug, which was carried to it. Doubtless to the delight of the ants, the result was as we may imagine it to have been anticipated. The mealy bug thrived exceedingly. The gland was enlarged still further and a whole family of mealy bugs was raised in the same hole. Thus a custom grew up and many such enlarged glands were found after a few

months. Here was an ant, then, apparently taking advantage of an opportunity which was new not only to the experience of the individual, but new to the experience of the race, and if we adopt the most reasonable of the definitions of instinct, here seems to have been displayed positive intelligence of a high order."

Such acts as the queen of *Polistes* occupying a comb of a previous year, the *Pompilus scelestus* enlarging her nest to accommodate a large spider which she had unsuccessfully tried to fit, the orientation flights of wasps, with their remarkable display of memory, etc., appear to be inexplicable from the standpoint of instinct alone. In fact, Buttel-Reepen [23] states that bees are able to gather experiences, to learn, and to form associations of impressions, and are therefore more than mere reflex machines.

Forel [10] believes "it may be considered as established that many insects (apparently all in some rudimentary degree) possess memory, *i. e.,* the power of storing up sense impressions in their brains and turning them to account later." On this basis, bees may find their way back to places where food is located although not visible from the nest. The same is equally true of the slave-raids of certain ants, *e. g., Polyergus.*

It is necessary to remember that in all cases we are interpreting insect actions from the human standpoint. We see insect life through human eyes, and there is a corresponding tendency to interpret it in terms of the human life.

We see a wasp jump on its prey *viciously* and later assume a *threatening* attitude, kicking *menacingly* at her enemies. We translate actions that we see in terms of our own emotions.

Do insects possess intelligence? It seems to me in the light of our present knowledge that all insect actions cannot be attributed to instinct alone. Each case, however, of cited intelligence must stand on its merits when subjected to the unbiased judgment of competent observers.

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HOUSEHOLD INSECT PESTS AND HOW TO ROUT THEM.

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There are many popular misstatements regarding insects, and similarly, misapprehension is found concerning the value of insecticides and closely related products. May I state at this time, that there are many inconsistencies noted among scientists relative to the important characteristics of these facts, but they are due more to a misconception of individual views, which are bound to be arranged shortly into a more uniform thought.

Education and not medication is the slogan or motto of the country in its attempt to prevent disease. The destruction of agents spreading or causing disease is a function so important to the protection of public health, that the materials and methods used must be known to be reliable and must be properly performed, not only by the practical and experienced sanitarian, but by the layman and general public as well.

I will confine my talk to indicate as clearly and briefly as possible the principal characteristics and properties of the commonly found insect pests, and the agents and methods employed to get rid of them, so that you, in your every-day routine, may be in a better position to intelligently practice the acts of sanitation, which, unfortunately, many are performing so haphazardly resulting in a loss of time, money, and at times in more or less faulty decisions or serious consequences.

The insect pests, which will be considered, are the ones that are commonly found in the household, such as ants, bedbugs, carpet beetles, cockroaches, fleas, flies, mosquitoes, and moths.

The important members of the latter are grouped under that large heading of "Arthropods," and specifically under the sub-group, known as "Insecta." It may be of interest to know, that in 1910, an Insecticide Act was adopted by the Federal government and a number of regulations were incorporated. This act resulted in the formation of the so-called Insecticide and Fungicide Board, in whom there is

vested the power of controlling the interstate traffic in insecticides and fungicides.

With the inauguration of this act, the board has accepted the following as the definition of the term insect:

"The term 'Insect' is understood to mean any of the numerous small invertebrate animals generally having the body more or less obviously segmented, for the most part belonging to the class Insecta, comprising six-legged, usually winged forms, as beetles, bugs, bees, flies, etc., and to other allied classes of arthropods, whose members are wingless and usually have more than six legs, as spiders, mites, ticks, centipedes, wood-lice, etc."

The term "Vermin" is widely misused. At one time and even today, it is restricted, by some, to small creeping animals, especially those classified under "Insecta." The persistent use of this term has become so widespread that it has been construed to include almost any animal that is harmful or even useless. It may be that after a better understanding of the relationship of the numerous pests and animals will be established, the term "Vermin" may be restricted to designate particular classes or species of animal parasites.

With the exception of the fly maggots, the insects, previously mentioned, rarely cause disease in man directly (*i. e.*, they themselves acting as the causative agents). They act mainly as intermediaries (go-betweens) in the transportation of agents, which cause disease in humans. As such, they act either mechanically or biologically. The mechanical method is practiced by the vast majority of insects. This merely consists in carrying organisms from infected material to man, or more frequently to foodstuffs and drinks, which are to be consumed by humans. Transmission by the biological method is practiced by a few of the insects, the most important of which are the Tsetse Flies and various species of mosquitoes. The biological method consists in the insect biting an individual, and with the introduction of its saliva, there is carried along with the latter the specific causative agent, which very quickly reaches the blood stream.

Insects pass through many stages before becoming an adult. These stages, explained as briefly as possible, are (1) Egg; (2) Larva; (3) Pupa and (4) the imago or adult. If insects undergo all of these stages, they are said to undergo a complete metamorphosis. If all

the stages are not reached, an incomplete metamorphosis is the result. Example—Complete—mosquitoes, flies, roaches. Incomplete—Bed-bugs.

It is my opinion based on practical experience and personal observation, that of the pests named, the laity, in general, use preparations to destroy the various types of roaches more than any other of the named insects.

Roaches.

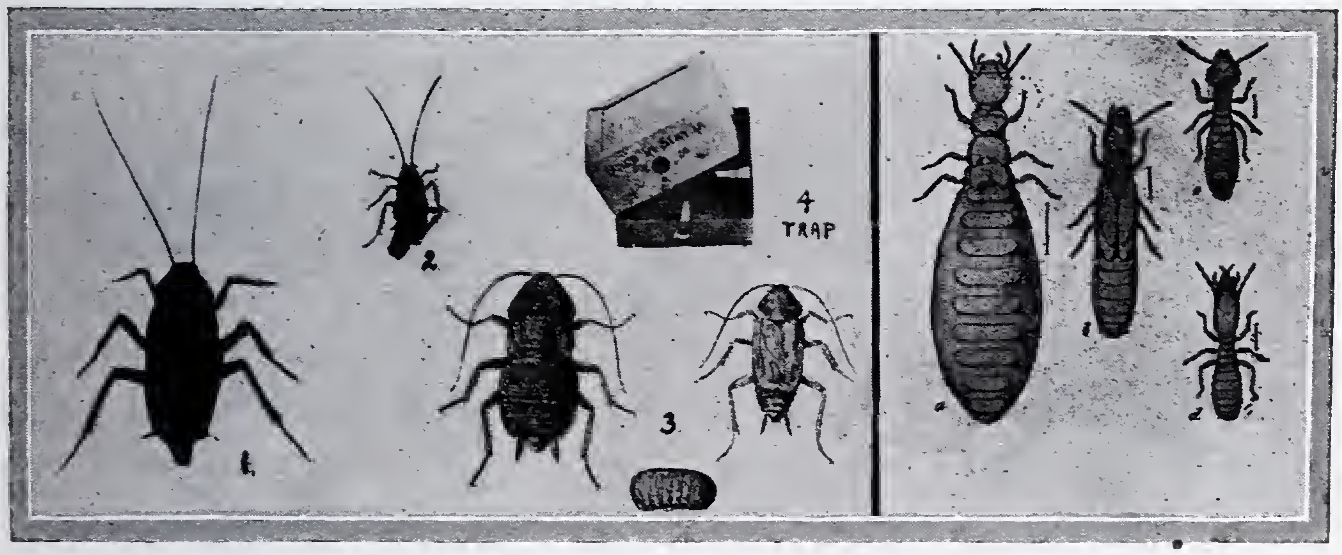
Roaches are the commonest, most annoying and most disagreeable of the various pests, which are found in the household. The common English name, "The Black Beetle," has been replaced in this country by the term "Roach" or "Cockroach." The roaches belong to a very large family. Though it is estimated that there are several thousand different species (*i. e.*, varieties) in the many parts of the world, it is fortunate that only a few (or to be definite—about four or five species) of these have become domesticated. The roach is primarily an inhabitant of warm countries. In the temperate zone, when found, it is generally observed during the warm seasons. For the same reason, the house roaches are found abundant in the neighborhood of ovens. fireplaces, in pantries, kitchens and generally, where the temperature is moderately warm, and preferably where moisture (*i. e.*, dampness) exists. Known to the ancients because of their habit of shunning light, one will find that even today they still possess this trait. Due to their thin, flat, slippery, bodies, they are capable of finding their way into all crevices and places where they would be out of the reach of all enemies, and where their presence would not be suspected. Rarely making their appearance in daylight, and usually hunting for food in the dark, they will eat all sorts of substances, due to the fact that their mouth parts are strong and well developed. You yourselves may have come into the pantry suddenly during the night, turned on the light, and to your surprise found many of the pests hurrying off to their places of concealment.

The male roach usually has two wings. These are less marked in the female, and in some species the latter may even be wingless.

It may be of interest to note, that the large number of roaches found are generally accounted for not necessarily to their rapidity

of multiplication, but on account of their habit of preserving themselves against the haphazard methods employed to destroy them, and due to the fact that there is a scarcity of natural enemies. Ordinarily, only one generation is produced each year.

The spread of roaches into new homes, is more often due to their introduction with furniture, household goods, shipments, etc., rather than to their migratory instinct. There is little known regarding the dissemination of disease producing germs by the roach, but it is thought by some, that they may be capable of assisting in the spread of the causative agents of the commonly observed Gastro Intestinal diseases: Typhoid Fever, Para-Typhoid Fever, Diarrhœa, Dysentery, and Asiatic Cholera. It is believed by some that they do this mechanically, contaminating foodstuffs and drink, after they, in their wanderings, have found their way over polluted sewage, dirt, filth, etc.



ROACHES.

1. Periplaneta Americana; 2. Blatta Germanica; 3. Blatta Orientalis.

ANTS (Termes flavipes).

a. Queen; b. Nymph of winged female; c. Worker; d. Soldier. (All enlarged.)

If we consider their numbers, one can safely say that they do not actually consume a large amount of material for food purposes. The great damage which they really do is the soiling of most all materials they come in contact with, by imparting a so-called "Roachy odor," which is foul and persistent. When foodstuffs and substances, that cannot be washed and cleaned well, are so tainted, it becomes necessary in many instances to destroy them.

Bedbugs.

It might be advisable to consider now another so-called bug, one which is very disagreeable, because of the well-known odor it exhales and commonly referred to as the "buggy" odor. This odor, due to a clear, oily, volatile liquid, emanates from various glands found in the bodies of these pests. The insect referred to here is the bedbug. The presence of the latter is not necessarily an indication of negligence or uncleanliness, for even the good housekeeper at some time or other has had to guard against them, or even contend with them after all precautionary measures have been instituted. Bedbugs are capable of migrating from place to place. It is therefore not a common occurrence to find even the clean home infested from time to time.

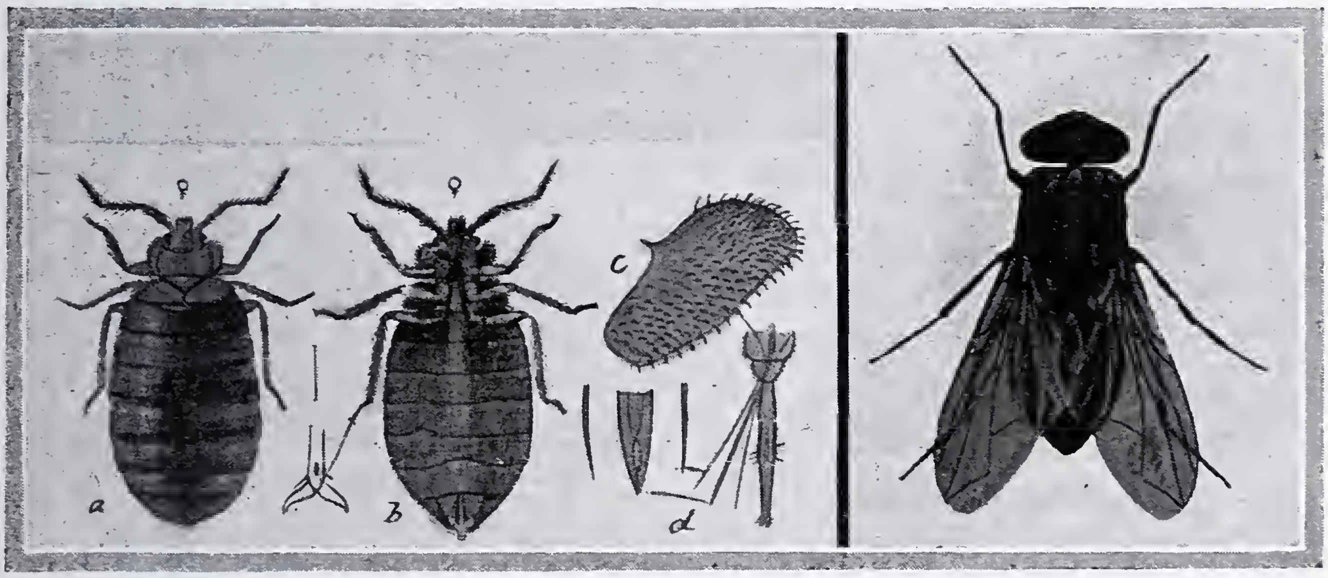
The bedbug has been associated with man as far back as records show. Pliny even mentions the marked medicinal properties possessed by these pests. Seven bugs ground up in water, he tells us, will arouse one from a fainting spell. We are told, that, even today, bedbugs are given as antidotes against fever and other conditions in certain parts of the world.

Though there are many species of bedbugs, the belief seems to prevail today, that there is only one important species which attacks man, while the other species confine their attention to birds, bats, poultry, dogs, etc. In tropical regions, it is said that some of these species attacking birds, etc., may become a human parasite as well.

The bedbugs are classified among a group of insects, all of which are characterized by possessing a piercing and sucking beak. Due to the frequent use of the latter, bedbugs have made themselves disagreeable pests. It is fortunate, however, that the bites of bedbugs do not produce great pain or marked swelling unless rubbed or scratched. In some people, a stinging, hard swelling may however be produced.

Bedbugs are normally night prowlers. Though they display a degree of caution in their efforts at concealment during the day, it has been known that under stress of hunger, they will emerge from their hiding places in a well-lighted room at night, or even feed in broad daylight. They thrive generally in filthy environments, while their favorite hiding places are in cracks and crevices, especially in wooden bedsteads, under wall paper, between boards and similar places, for which their flat bodies are adapted.

Generally, it has been found, that human blood is the normal food of the common bedbug, though, experimentations have revealed the fact, that they may subsist on the blood of other animals. It is but seldom, that the bedbug adheres to the skin, while getting its supply of blood. It prefers to remain on the clothing. Inasmuch as it has been observed that a fresh supply of food seems to act as a stimulus for emptying the contents of the rectum, the finding of excrement on the clothing rather than on the skin, prevents to a great extent the contamination of wounds made by bedbugs. A single meal, which takes from five to fifteen minutes, and which distends the bug, giving it a round appearance, will require from five to ten days, before it is completely assimilated. Though the bedbug retreats to its place of concealment after partaking of its food, it may not necessarily wait until all of the latter is assimilated, but will come forth within a few days to feed again, so that in its stomach there may be found parts of several meals.



BEDBUG (Cimex lectularis). **HOUSE FLY.**

a. Adult female gorged with blood; b. Same from below; c. Rudimentary wing pad; d. Mouth pads. (a. b. Much enlarged; c. d. greatly magnified.)

The statement that bedbugs can live under bark, moss, woods, logs, in dust, etc., arises from a misunderstanding. This misconception is probably due to the fact that various stages of other insects have been mistaken for the bedbug. The presence of this insect in non-inhabited environments for long periods of time is due to its ability to survive without food for almost a year, perhaps due to the fact, that they store up a great deal of fat for use in time of famine.

The rate of multiplication of these pests varies depending upon food supply and environmental factors, as temperature, etc. Allowing the fact that there is a moderate degree of heat in the winter months, where bedbugs are found, one will find that there may be about four successive broods in a year.

Bedbugs are strongly under suspicion as carriers of some communicable diseases, but its exact role as a disease-carrier has not been satisfactorily determined. Bedbugs have been associated with many diseases in the tropical countries, but the evidence brought forth in the support of these insects as being transmitters of these diseased conditions, seems to rest on insecure foundation. Others have attempted to show that bedbugs may act as mechanical spreaders of other diseases. Bubonic Plague, Leprosy, Tuberculosis and certain skin diseases have been said to be transmitted in a mechanical manner by these insects.

Fleas.

Perhaps of the house insects, fleas, when present, are one of the most troublesome pests. They are mainly annoyers of man and animals. As such they have in many instances rendered houses uninhabitable for a time, and caused considerable loss among poultry, pets, etc. Fleas, however, transmit disease. Certain tropical and semi-tropical diseased conditions are perhaps transmitted by fleas, and the dread Bubonic Plague is now known to be transmitted almost solely through the agency of several varieties of fleas. Hundreds of species of fleas have already been described, most of them being of no importance to man, and seeming to prefer to live on some one particular animal, upon which they thrive. The exact identification of the species of fleas is not always a simple matter, but this can generally be determined, if the host and geographical locality are known, by the presence or absence of the so-called combs on the head and thorax.

The life history of all fleas is about the same, possibly with little variation. They undergo a complete metamorphosis, that is, during its life four distinct stages are apparent—egg, larva, pupa, and adult. The fleas generally lay their eggs singly over a considerable period of time. These are deposited either in dust, in cracks in floors, under carpets, in the fur of animals, to be thrown off of the latter when they shake themselves or go to sleep. These

eggs are oval, whitish and relatively large, and are easily observed, when on dark colored cloths and objects. The eggs hatch in from three days to two weeks, depending upon the particular species and the existing climatic conditions.

The larvæ are very active, avoid light, and feed on almost any kind of refuse, in cracks, carpets, in the nests or even the hair of animals. The duration of the larval stage also varies with the atmospheric conditions, and with the particular species. This may under favorable conditions be a week, or under unfavorable conditions may be drawn out for several months. When ready to transform, the larvæ spin small, viscid, silken cocoons.

The adult flea may emerge from this cocoon in from two to fourteen days, but under adverse conditions, the pupal existence may be extended for many months. Ordinarily, the life cycle of the commonly observed varieties of fleas is passed through within a minimum of three weeks. The life of the adult flea varies not only upon atmospheric conditions and food supplies, but also as to the particular species. Adult fleas feed on the blood only, and unlike most blood-sucking insects, they feed at frequent intervals. The capacity of the stomach of fleas is not great. They are very easily disturbed, and seldom complete a meal at one bite. The human fleas visit their host mainly at night, whereas others, like the cat and dog fleas remain in the fur of their hosts constantly. When well supplied with food, the adult may live from a month to a year, while with unfavorable weather conditions and improper food supplies, they rarely live over a period of two months.

Whether it is accidental or incidental, it seems that a humid, warm climate or mild wet weather are ideal conditions for the successful development of these pests. Though it is a fact, that the larva and pupa require a certain amount of moisture, and that adults live better when some moisture is present, it should nevertheless be noted that excessive moisture is as detrimental to their existence as is excessive dryness. Banks of sand are ideal places, as the latter maintain moisture more uniformly. The important species which human beings come in contact with, are the human, dog, and cat fleas. Various species of rat and squirrel fleas may become accidental parasites of man, while the chiggers or sand fleas and the sticktight fleas are other members which may become human pests at times.

Old carpets, straw mattings, old clothing, hats, dusty cracks in floor boards, etc., dirt and filth in corners, are generally the breeding grounds for the human flea or for the dog and cat fleas, which may have been spread about the home by pet animals. When no such breeding places can be found in the home, and fleas still persist, there is a possibility that they are being carried into the home by dogs and cats and other pets, and that the actual breeding places may be in cellars, sheds, barns or under the building where these animals stray or visit frequently.

The fleas commonly found on dogs and cats generally locate on the ears. In the case of chickens, they seem to attach themselves in clusters on their heads. Young chickens, when heavily infested, die very quickly.

The Indian rat flea is the species most intimately associated with the transmission of Plague. It is however probable that many other species may transmit this disease. By colonizing on infected rats, fleas play an important part in disseminating Bubonic Plague. The destruction of the breeding places of rats will assist greatly in the extermination of many species of fleas.

Flies.

It may be of interest to note that, though the mosquito is of great importance, because it is instrumental in the spread of human diseases, it belongs to the same order in which the flies are found. The term fly includes many species. All of the latter have characteristics peculiar to themselves. The important members are the following, "Phlebotomus Flies," sometimes known as "Sand Flies" or "Owl Midges," which are known to be the sole disseminators of certain fevers in tropical and semi-tropical areas; second, the "Black Flies," or "Buffalo Gnats," which in certain areas are the most common annoyers of domestic animals and man—not so much as carriers of any disease, but due to the havoc which they cause directly when biting; third, the "Gad Flies" or "Horse Flies," which are primarily of importance as blood-thirsty pests of domestic animals, and as mechanical disseminators of various disease germs, Anthrax being the most important one. Fourth, the "Tsetse Flies," which, next to the mosquito, are the most important of the biting flies. It is not only their biting power, but mainly their role as transmitters of African Sleeping Sickness, which puts sanitarians on the lookout for this mem-

ber. Fifth, the "Stable Fly," which is annoying and often dangerous almost over the entire world. They have been found to be mechanical transmitters of various diseases. Sixth, the "Midges," known also as "Punkies" or "No-See-Ums," which, though not disease carriers, are at times terrible pests; and last but not least the "Common House Fly."

The true house fly differs in one important characteristic from the other members, in that it does not bite. It will breed in horse or any other animal manure, human excrement, and in a great variety of decaying animal and vegetable matter. In favorable warm weather, a new generation may be expected within every two weeks. During the cold period of the year, it has been experimentally observed and practically proven that most adult house flies are really killed. There is no evidence to definitely show that flies, as adults, hide in cracks and crevices, and appear when conditions become favorable. The only way in which house flies may pass the winter is either as larvæ in or beneath manure piles, etc., or in rare cases by continuous breathing in heated rooms or warm environments. The body, especially of the house fly, is covered with hairs and bristles, so that they readily become contaminated with microbes when crawling over various materials. Bacteria and other causative agents of disease may be ingested by these pests, and live for long periods of time in their alimentary canal. Their visits to human foods result in the contamination of the latter either from the hairs, bristles, and body excrement, as well as in regurgitated matter.

Other than the fact, that all flies are dangerous insects and important factors in the spread of diseases, there is another way in which they may be a menace to health. The human body is subject to attack or invasion by the maggots or larval stages of some species of flies, resulting in a condition known as "Myiasis"; Cutaneous Myiasis, being the presence of fly larvæ in the skin; Intestinal Myiasis, being the presence of fly larvæ in the intestines. The type of maggots which develop in or under the human skin is more apt to be observed in tropical or semi-tropical countries, where personal cleanliness is far below the standards we are apt to see in the many civilized countries. In like manner, one is apt to find that flies occasionally deposit their eggs in neglected wounds or exposed dead bodies. In some instances, one may hear of maggots in the ear. Intestinal myiasis, though not a common condition, is apt to be

found in humans, contracted by eating decayed fruits, vegetables, meats, cheese, pies, puddings, etc. Their effect in the intestines depends first on the species of flies; second, the numbers taken in; third, the individual's susceptibility. There is no doubt that there are many cases of intestinal myiasis, but these are never known or suspected, because symptoms have not been pronounced. Unfortunately, the cases, which have been reported, have only been detected after much damage has been done. Prevention consists mainly in taking care that no decayed or partly decayed fruits and vegetables are used, and if foodstuffs cannot be well cooked, care should be taken in cleaning well all materials, especially raw fruits and vegetables.

The eggs of the house fly generally laid on horse manure, human excrement, etc., will hatch, if conditions are favorable, in from eight to twelve hours. The number of eggs laid by an individual fly, at one time, average about one hundred and twenty, and are usually found together in clusters. The larvæ or maggots, which are produced, become fully developed in from eight to fourteen days. This period may be prolonged greatly by unfavorable weather conditions and improper food. They then change to pupæ, in which stage they remain for another eight to twenty days, when the adult fly will emerge. As in the case of life histories of all insects, there may be a prolongation of these periods due to unfavorable conditions. However, it may be said that under climatic conditions, as favorable as we have it here in the summer time, one may expect a new generation to start every two weeks.

From this, it may be seen that a single female fly may be responsible for countless millions of flies during a season. One can therefore appreciate the necessity for methods of eradication, which are to be and should be practiced persistently during the early spring.

The carriage of the causative agents of Typhoid and Para-Typhoid Fevers, Asiatic Cholera, Dysentery, Diarrhœa, from latrines, privies, and refuse, to food by flies is of more or less frequent occurrence, and at times results in epidemics of these diseases. There is also strong evidence that Diphtheria, Scarlet Fever, Tuberculosis, and other respiratory diseases, Anthrax, Smallpox, the eggs of various parasites and worms, as well as the causative agents of some of the tropical diseases may be carried and disseminated by the fly.

Mosquitoes.

Of the many insect pests, which are here considered, mosquitoes are perhaps the greatest enemy of man. Other than their importance from a sanitary viewpoint, they cause considerable annoyance by their painful bites when attacking individuals. There are many parts of the country and of the world which are desirable either as permanent quarters, temporary camping grounds, hunting and sporting places, but which are practically closed and unsettled, on account of the presence of the mosquito. They are just as numerous in the cold countries, as in the tropics. In fact, it is claimed by many workers that the Northern Countries contain greater numbers of mosquitoes, than are found in tropical areas. There is this to be said for the mosquitoes found in cold climates; they bite, obtain their supply of blood, which is their food, and then rest. The Northern Mosquito is not a carrier of disease. The mosquitoes found in tropical climates, in addition to the discomfort they cause by biting, may cause considerable worry, suffering and death, by depositing, as they bite, deadly germs, which remain to act as poisons to one's system.

Mosquitoes are members of the great insect order in which are found many pests, as the sand flies, black flies, midges, etc.

Most of the members of the mosquito family are distinguished from the other pests, belonging to the same order, by the characteristic and conspicuous fringe of scales present on the hind margin of the wings.

In a general way, the life histories of all species of mosquitoes are alike. There may be special characteristics in physiology or in habits, which are more or less present, so as to meet the existing conditions of environment, etc. The number of eggs, which are generally oval in shape with various markings, will vary anywhere from twenty-five to several hundred. Some lay their eggs singly, while others lay them in groups at one time. Some species, as found especially in temperate climates, will lay their eggs on the open surface of standing or stagnant water, while other species found in the cold and tropical areas may deposit their eggs in dry places, which are soon covered with water. In the temperate climates, the eggs generally are hatched within twenty-four hours, while in the far north or in the dry, hot countries, the eggs probably do not hatch for many weeks or months, having been more or less acclimated to, or fortified by unfavorable climatic conditions.

The eggs of mosquitoes only hatch in the presence of water, and it must be standing water. At first, they are very minute, but rapidly obtain a length visible to the naked eye. The larvæ, developing from the eggs, are always aquatic. Most of the species possess a trumpet shape breathing tube, which pierces the surface film of the water, drawing in air, for, though aquatic, the mosquito larvæ or wrigglers, as they are known, are air breathers. Unless the water is well aerated, the larvæ make frequent trips to the surface, hang head downward, and breathing through their tails, obtain their air supply. In a water containing no dissolved air, and from which the air from above the surface is excluded, mosquito larvæ will die within a few hours. The length of time required for the mosquito to complete the larval existence depends entirely upon the temperature. It will require anywhere from five days to two weeks, before the resting or pupa stage is reached. The pupæ never eat, but are most always found, head upright, at the surface of the water, quietly breathing. The transformation into the adult stage may in some instances be a matter of a few hours, but in most species, from two days to a week, depending on the condition of the weather, are required before a full-fledged mosquito is produced.

The different types of mosquitoes exhibit great variability as to their food supply, where they hibernate, choice of breeding places and other habits. It may be of interest to note that recent investigations have proven, that most all species of mosquitoes have some habits which are peculiar to themselves. For instance, we are capable of distinguishing between mosquito larvæ, the adults of which carry Yellow Fever, and those which carry Malaria, because the Malarial Mosquito larvæ lie almost parallel to the surface of the water, and Yellow Fever Mosquito larvæ hang nearly perpendicularly The position of these two larvæ are just the opposite of the species of the adult, when at rest.

There are some species which breed in salt marshes, holes in trees, plants, and swamps, etc. Others have become domesticated, and may be found around the house laying their eggs in water troughs, flower pots, spittoons, buckets, bottles, or in any collection of standing water in or about the home. Some prefer clean water, others filthy water, and still others show no preference. Another important fact only recently recognized is that most mosquitoes seldom stray from their breeding grounds. It is a false impression,

which has led individuals to believe that mosquitoes are carried long distances by strong winds. This is only true of but a few species. The common salt marsh mosquito (the mosquito that made New Jersey famous), is perhaps the only commonly observed species of mosquito, which, though breeding in enormous numbers along marshy coasts of New Jersey, have been found to migrate inland. Some observers have even claimed these species have traveled as far as thirty or forty miles. With the exception of these salt marsh species, the kinds of mosquitoes you find in your home do not fly long distances, only under unusual conditions. You may be rest assured, that if there exists an abundance of mosquitoes, their breeding place is nearby, generally, within a few hundred feet of the environment which is infested. Any puddle of water, whether present in cesspools, drains, street gutters, or rain gutters in or about the home,

HOUSE MOSQUITO (Culex pipiens).
1. Egg mass; 2. Larva; 3. Pupa; 4. Adult.

RESTING POSITIONS.
House mosquito. Malaria mosquito.

pools, dirty containers and receptacles in the neighborhood, a pond, rain barrels or any other stagnant water on or near your premises, no matter how small or how foul, large or clear, is an acceptable breeding place for mosquitoes. It is therefore of the greatest importance to remember that the eggs can only develop with stagnant water about. No standing water means no mosquitoes.

The male mosquito is generally a vegetarian and does not bite. It is the female mosquito that does the biting and damage to the human being. The male is differentiated from the female not only in the fact, that there is a difference in the construction of the proboscis (*i. e.*, name given to the elongated projecting nose and trunk)

so that the male mosquito cannot pierce flesh, but one will generally find that the male has very bushy antennae (jointed feelers upon their heads), while the female's antennae are very sparsely plumed.

From a sanitary standpoint there are three different kinds of mosquitoes, which are important because they assist in the spread of disease conditions; the Anopheles Mosquito, transmitting Malaria; the Stegomyia Fasciatus or Aedes Calopus, transmitting Yellow Fever; and Culex, transmitting Dengue and Filariasis.

The Anopheles comprises a number of species, only some of which are capable of transmitting Malaria. Most all species are more or less domesticated, and are generally active only at twilight. They rarely wander about in bright daylight, nor in the darkness of night, though inside of homes, one may be bitten by them any hour of the day. The Anopheles may breed in almost any standing water, providing there are present microscopic organisms on which it may feed. The Anopheles, more commonly than other types of mosquitoes, generally pass most of their time in or around their breeding place, and, as a group, they are incapable of any long flight, rarely even a few hundred yards.

The mosquito transmits the diseases mentioned by what is known as the biological method. These diseases are caused by microbes, invisible to the naked eye, which live and multiply in the blood of the person suffering from this disease. The female mosquito, by sucking the blood from such a person, takes into its stomach the disease producing organisms which develop partially in the body of the mosquito. The microbes (which in this instance are specifically members classified among the animal parasites), when in this stage of development, which takes about ten days, may be found in the stomach, intestines, and salivary glands of the mosquito. When the latter bites a person, it generally throws forth its saliva, so that it may dilute the blood, which ordinarily is too thick to be sucked up through the tiny tube in the bill of the mosquito. During this process however, the disease producing microbes are also deposited in the wound, which is formed. These reach and multiply in the blood of the person bitten, and either, in themselves, or by the poisons they produce, cause the symptoms of the respective diseased conditions.

As far as is known, Malaria and the other diseases mentioned above are caused no other way, than being bitten by infected mosquitoes.

The proof that Yellow Fever comes to us through its dissemination by mosquitoes is the result of that never-to-be-forgotten and honored work of the American Army Yellow Fever Commission, which, before it was completed, resulted in the loss of three of the lives of America's renowned and illustrious scientists, Drs. Carrol, Lazear and Reed.

Yellow Fever is a disease, which is especially characteristic of seaport towns of South America and more or less common in South America, Africa, and most all tropical countries. Though the American Commission has definitely shown how the disease is transmitted and disseminated, the causative agent of this disease is unknown. Unlike the conditions as regards Malaria, Yellow Fever can be transmitted by only one species of mosquito—the Aedes Calopus or Stegomyia Fasciatus. Extermination of the latter means the eradication of Yellow Fever.

The Yellow Fever Mosquito is perhaps the most domesticated species known. Showing a decided preference for human blood, this pest has been long familiar to man, and rarely is found unless in the vicinity of homes. From long and close association, it has apparently learned to hide itself behind and under objects, and even in pockets, and in the folds of garments. In the early morning and during the afternoon, it rarely bites in the dark, but generally in lighted rooms, and seems to have the habit of crawling up under the clothing to bite, rather than attacking exposed surfaces. Even though Yellow Fever is not prevalent in many countries, there is constantly a danger of the introduction of this disease into places, where it has not previously been known. It becomes necessary at all times to consider the practical extermination of this mosquito, due to the fact, that there is a possibility at times of its importation.

Dengue or Seven Day Fever, as well as Filariasis, are diseases of tropical and sub-tropical countries. The causative agent of the latter is known, while the true cause of Dengue is unknown.

Ants.

There are many species of ants in existence, but in the western continents about twenty-five species have been observed, and only a few of these are to be found in the household. In this part of the hemisphere, they are found in the soil, during the warm seasons, and in heated homes. It may be of interest to note, that most of

the species of ants are practically of tropical origin. None of them. as far as is known, are disseminators of disease. Most of them are annoying, merely because of their presence and likelihood of getting into foodstuffs. One of these species, the so-called Carpenter Ant, is however, very destructive to household effects, especially to foundation timbers.

Most of these species seem to possess the same habits and characteristics. The commonly observed ants are extraordinary workers. Their nests are more frequently in the garden, or other soil near the house, rather than within the home.

Moths.

Millers or moths, observed around the household generally possess a buff color. The ones that are the chief offenders among fabric pests are rarely found directly around lights. The latter prefer darkness and therefore conceal themselves in clothing, cracks and dark places. The moths that are frequently found about the lights in the home are the ones that feed on vegetation on the outside, rather than on household fabrics and their presence is really accidental, being attracted into the homes by the lights.

It may be of interest to note, that the adult moth cannot feed on clothing, as it possesses imperfect mouth parts. Their main interest to the housewife is the fact that the moth lays its eggs upon the object it attacks, generally in or about clothing. From the eggs are hatched the larvæ or worms. It is the latter that cause the destruction. If conditions are favorable, the larvæ stage then passes to the pupa, and finally the adult moth is the result. One may therefore observe that the destruction of the adult moth will eventually save clothing and other furnishings by the prevention of the laying of more eggs.

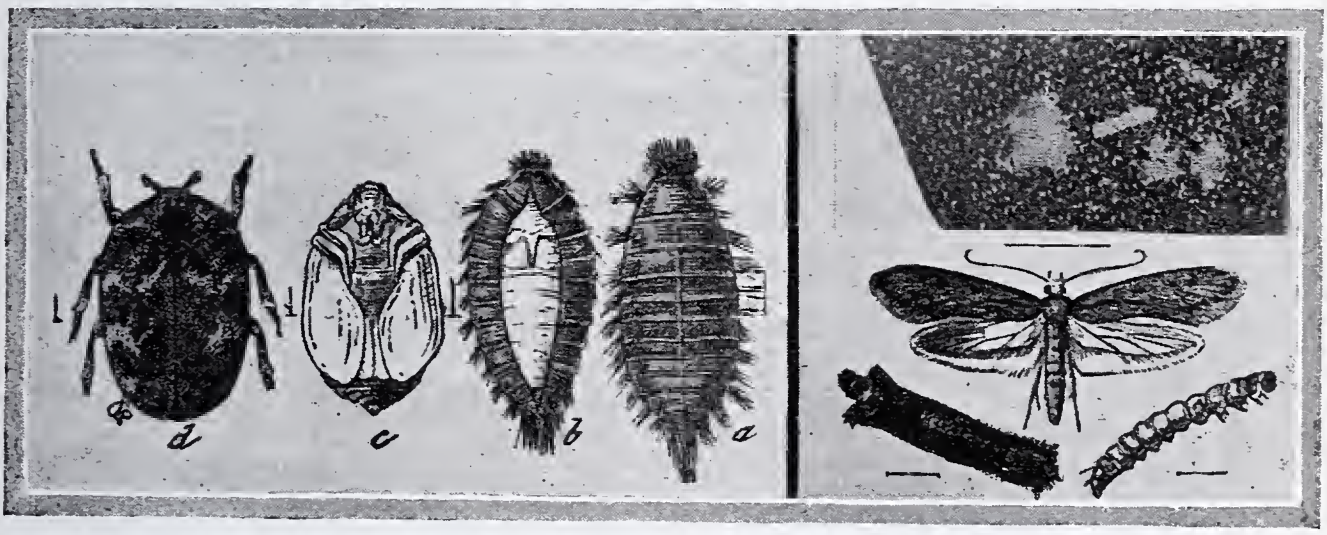
The three most important and commonly found species of clothes moths are the "Webbing Clothes Moth," "The Case Making Cloth Moth," and the "Tapestry Moth."

The Webbing Clothes Moth is the most abundant and injurious of these species, causing damage to clothing, furniture, all types of fabric, carpets, rugs, stuffings in animals, birds, in furniture and so forth.

The Tapestry Moth is not so common in this country, as the other two species, and it is claimed that it prefers heavier and coarser materials, as blankets, felt, furs, and even wall paper.

The adult moth rarely lives more than three to four weeks. It however begins to lay eggs when only a few days old, and usually every day thereafter until a few days before it dies. As far as has been observed, the adult moth does not require or take nourishment. The eggs that are laid either singly or in groups of twenty or more are not individually as large as a common pinhead. They are very easily crushed and destroyed, shaking being sufficient to kill them. The eggs generally hatch best in warm weather in from four to eight days. In cold weather it may take from two to four weeks.

The larvæ, which are formed after hatching, will vary in size. Atmospheric conditions and the nature of its food supply have an important influence upon the growth of the larvæ, the only developmental stage in which the clothes moth damages fabric. There is no definite time limit which one can give as the requirement for further development. It may take as little as four and as long as twenty-four months before the pupa stage is reached. The food and environment govern the latter. The pupa stage will last about a week in warm weather and about two months during cold weather.



CARPET BEETLE (Anthrenus scrophulaviœ).
a. Larva, dorsal view; b. Pupa, within larval skin; c. Pupa, ventral view; d. Adult. (All enlarged.)

CLOTHES MOTH (Tinea pelliomella).
Above, adult; at right, larva; at left, larva in case. (All enlarged.)

Carpet Beetles.

Buffalo Moths, more frequently called Carpet Beetles, are closely associated with Clothes Moths in their destruction of household materials. Though the larvæ are found most frequently beneath carpets, they have been found to feed upon other articles, such as upholstered furniture, dried animal matter and articles con-

taining wool, fur, hair bristles or feathers. These pests are very distinct from the true Clothes Moth, being in reality a beetle and not a moth. Of the six species found, four have proven to be serious offenders in the household. The appearance of the adult stage of the most common variety of the Carpet Beetle is that of a small, broad, oval, insect, almost one-fourth of an inch long, covered with minute scales, and possessing a mottled black and white appearance. The adults generally are present in the fall. Eggs laid by the females in convenient spots will hatch in a few days. The larvæ develop quite rapidly if the proper food supply and favorable atmospheric conditions prevail. The larvæ remain secluded in dark places, beneath carpets, garments and other materials causing destruction of the latter. Eventually the pupa stage is reached, from which the beetle emerges. When not engaged in laying eggs, they are attracted by the light, and also when flying about are apt to go through open windows, being attracted to flowers and certain plants. Ordinarily they reproduce once a year and not very abundantly.

Closely related to the common Carpet Beetle, we have the Black Carpet Beetle and the Varied Carpet Beetle, which possess different color arrangements. They are not unlike the common Carpet Beetle, in so far as their most important characteristics of general interest are considered.

The other important species is the Furniture Carpet Beetle, which is well established in certain quarters of this country, and is a serious pest, destroying hairs, leather, linen and other coverings.

Methods of Eradication.

It is impossible to cover in more detail the complete life histories of the insects mentioned, due to the short period of time that has been allotted. May it suffice to say that in a sense, their lives are just as mysterious as ours. If you care to study them further, you will find that their work is just as wonderful and as interesting, and their actions are as unfathomable as that of man. The presence of the stinging insect on our bodies, or in our environments, is primarily in the pursuit of food. The rest is merely incidental as far as the insect is concerned. But it is this incidental act, which has and is constantly causing such large economic and human losses to people of our own and other countries. Fields, gardens. etc., are devastated or seriously affected. Forests are made waste places, many environments are made uninhabitable. Thousands and

thousands die year in and year out, and a monetary loss of amounts which can hardly be determined is entailed, due to the destruction of materials and substances, let alone the great suffering and misery, endured by the afflicted and immediate dear ones—all this on account of just a few of these insect pests. It would be impossible even to think or attempt to make an estimate of losses, if we should take into consideration other pests.

But there is no doubt, that, to a great extent, much of this loss could be prevented by every housewife. It, of course, needs the hearty co-operation of all.

It is unfortunate that many consider it a disgrace or a sign of uncleanliness to be visited by ants, bedbugs, roaches, etc. As has been pointed out, these may gain access to a dwelling not only because of their migratory habits, but they may be brought into the home along with any article coming from the outside. Failure to attempt to eradicate these pests is more often due to a mistaken sense of shame, rather than ignorance on the part of those in the dwelling. But whether it is an indication of shame or lack of common sense, failure to institute immediate efforts towards eradication is to be condemned.

The first important principle to keep in mind in ridding a place of insects is that if there is no food for them, they will not remain. If there are no breeding places, there will be no offspring. The whole problem of successfully combating many of the pests discussed, is in finding and destroying the breeding places. These breeding places may be readily found, if one is familiar with the life histories of these insects. In most cases efforts directed against the adult insects are usually less successful in decreasing their numbers, than if the same energy is spent in fighting their breeding places.

Uniform cleaning up matters in the home, will materially lessen the number of breeding places and in turn the number of insects. It may be best to use as a working principle that "To keep clean is better, cheaper, safer and more effective than to make clean after vermin and dirt have accumulated." Dust and dirt allowed to remain in any place is soon covered with grease, and foci for breeding places are thus formed. Sweeping and cleaning can be made and should be made as dustless as possible. Remove the dust, don't scatter it. Orderly arrangement of materials in closets not only

makes cleaning easier, but it becomes a simple matter to detect insects and their breeding places. Closets as well as cellars, basements, and other storage places should be regularly ventilated. All crumbs and food particles in the pantry, kitchen, etc., should be cleared away. All food should be placed in covered containers. Garbage, filth and dirt, should be kept in closed receptacles, and removed at frequent intervals. Decaying vegetable or animal matter in or near the house should be removed or treated with proper destructive agents. Buckets, barrels or other receptacles in or around the home should be either covered, screened, or turned upside down and no stagnant water should be allowed to stand in or around the house. Roof gutters, cesspools, sewers and other traps should be examined frequently, to be sure they are not clogged, thus allowing the accumulation of water. Water in pans or troughs for domestic animals and pets should be changed frequently.

It is advisable that carpets should not be tacked down to the floor. The latter as well as clothing and other apparel in closets, chests, trunks, etc., should be removed at least once or twice a year, shaken well, and allowed to receive the benefit of the air and sunshine for a short period of time. Pets as cats, dogs, etc., should be provided with sleeping places that can be kept clean. It would be best to supply them with a blanket or mat to sleep on. The latter can be shaken frequently, thus preventing the collection of dust. If at any time a home is infested with the insects discussed here, it will be found best to burn the dust and refuse that is collected when cleaning, rather than throwing it in a container to be taken away. Cracks, and holes in floors, walls, around pipes, etc., should be filled in with suitable filling materials. Windows and outside doors should be screened, especially during the warm months. It is important to emphasize that this screening should be carefully performed, as it is not a common occurrence to find one will take the greatest precaution to screen the entire house, but windows and doors leading into the cellar or basement are overlooked. It is also advisable to be sure that the screens are so constructed that there should be twenty or more meshes to the inch, as otherwise the mosquitoes may pass through the netting. Exposed foodstuffs, not only in homes, but also in shops selling food supplies, should be screened or otherwise covered, so that flies cannot gain access to them. In public places, the free use of electric fans will help keep flies away,

due to the fact that the latter cannot stand the draught which is created.

Many of the points enumerated may either decrease the number of insects and also lessen (as in the case of screening of foodstuffs) the danger of contamination. Undoubtedly the most efficient remedy to be practiced in undertaking the control and extermination of household pests is in the prevention of the breeding places, or at least the making of the latter uninhabitable, and the destruction of the pests, before the adult stage is reached. Individual effort along such lines is an absolute necessity, but an intelligent united, and organized action in a community may be essential to insure satisfactory or permanent relief. Without such united effort, reinfestations from adjoining property are always possible.

Certain natural enemies of these pests are to be found in or around our homes. The house centipede and the common little red house ant prey upon bedbugs. Flies are also destroyed by the former, by ants, certain beetles, Fungi and even by birds and bats. Birds, fish, dragon flies, spiders, toads, beetles, internal and external parasites devour mosquitoes. One can readily see that these natural enemies are as unwelcome as the pests themselves and have but limited use, if at all, in any program to control effectively the household insects discussed. They cannot be relied upon to do the work for us. Mention is made here of the existence of such enemies, merely to inform you of the destructive possibilities that exist in replacing some pests with their natural enemies. To cite a specific and important instance of this kind, would be to mention that successful attempts have been made by some in eradicating the Japanese Beetle (which is so destructive to our crops), by various natural enemies, that are not destructive to the latter.

In spite of all the precautionary measures, as previously mentioned, these insects may gain access and find their way into the household. Either through their migratory instinct or their introduction by hiding in materials to be shipped, premises may be temporarily invaded. If left undisturbed, their numbers will increase with almost unbelievable rapidity. Once these pests have become entrenched, determined effort is required to eradicate them. Unfortunately, an endless variety of control methods have been introduced, and a countless number of destructive agents have been exploited and advocated as part of the proper campaign to be assured of the

riddance of these pests. If the destructive agents offered for sale by some, and methods of eradication as advised were only partially as effective, as the results of the salesmanship or advertisements generally introduced, we would be rid of these pests by now.

It cannot be stated too emphatically, that these pests can be eliminated from the home, providing the methods employed are rigidly and intelligently enforced. Most failures are due partially to the use of inefficient methods, but more so to a half-hearted effort and easy discouragement, resulting in a haphazard and indifferent technique in enforcement.

The use of baits, adhesive papers, traps, repellents, poisons and fumigation to control and destroy these insects that have gained access to houses are well known, and will be considered first. May I impress upon you that the use of these, though at times desirable, are but temporary conveniences.

Unfortunately some of the most efficient of the above are agents and procedures that can be rarely used in a home. Baits containing various poisons are most effective for the destruction of many of these pests, but can only be used where children and domestic animals are not about, and only by responsible individuals.

A very effective poisonous bait for ants is to moisten a sponge or piece of bread with a syrup, made by dissolving an ounce of water and ten grains of arsenate of soda in two ounces of hot water. It has been found that some of the ants may carry the poisoned liquid back to the nest, resulting eventually in the destruction of the entire colony. The employment of this effective bait, if used with care, may replace the applications of the many insecticidal preparations, which, principally on account of the odor they impart, cannot be conveniently employed.

Poison baits and poison preparations for flies are also common. Some of the latter are made with compounds of arsenic. The use of the latter, as mentioned, is attended with danger. In place of these, one will find that a weak solution of formaldehyde is very effective. Such a preparation can be made by buying some Formalin or Solution of Formaldehyde. One fluid ounce of the latter added to a quart of milk or sweetened water can be conveniently placed in glasses, saucers or small shallow pans in the doorway, in the pantry or wherever the flies are found. The United States Public Health Service has recommended the use of a solution of salicylate of soda,

made by dissolving one ounce of the powder to a quart of sweetened water. A piece of bread or other foodstuff may make the bait more attractive.

Some have at times advocated the placing of phosphorous paste on the inside of small tubes of folded cardboard, paper, etc., as a bait for roaches and even other pests. Small dishes filled with mixtures of equal parts of flour and plaster of paris, where roaches and other insects appear, have been found as another effective bait. It is claimed that the insect is soon compelled to drink water, which results in the hardening of the plaster of paris and death of the insect.

It is important to remember, that, if baits are to be employed, they should be placed in environments, either frequented by the insect pests, or where they are apt to be present. Always be sure to place them in inaccessible compartments, so that children and pets may not reach them. It is also desirable that the baits should be distributed freshly and freely at frequent intervals.

Trapping.

The trapping of certain house insects is perhaps a very effective procedure and is highly recommended where the use of poisons seem to be inadvisable. This method is to be desired and should be more commonly used, especially to assist in decreasing the number of flies, rather than the use of adhesive and other types of fly papers, or swatting the latter with various implements. There is no doubt that the finding constantly of fly papers in or about a home or food shop tends to leave an impression, which is indeed not desirable. In like manner, swatting the fly does not kill the eggs and merely assists in the distribution of any bacteria that may be present on the fly. If on the other hand, one resorted to the use of baits or fly traps, much more efficient results will be obtained with the expenditure of less energy, as well as a neater appearance in the particular environment.

The traps are generally so constructed, that the particular insect may easily get into them, but cannot escape. Traps for roaches and especially for flies have been found very effective. There are many types on the market, but home-made devices are easily made. As a bait both for flies and roaches a mixture of three or four parts of water and one part of molasses, which has been allowed to fer-

ment, has been proven to be very attractive. The trap is baited daily and the catch destroyed by treatment with boiling water. It is important that traps employed for flies should be constructed so as to permit plenty of light to appear from the top, as otherwise the bait may not be seen by them.

Various devices for catching fleas and mosquitoes are available, but are not as yet employed extensively.

Temperature Control.

The possibility of temperature control in the eradication of insect pests from the household is of considerable interest, perhaps most effective, one of the simplest of methods, and one which is infrequently employed. In real cold climates, or in those localities where the winter is real cold and homes untenanted, having been used for summer residence only, if a temperature slightly below freezing is maintained constantly in infested houses for a few weeks, the eggs, newly-hatched young, and most of the adults of most all the insects pests mentioned would be exterminated.

More efficient than cold temperatures, and a technique which can be more readily applied is the maintaining of high temperatures in households for destructive purposes. Temperature varying from 115 degrees Fahrenheit and over is found sufficient to destroy quickly, fleas, flies, roaches, bedbugs and other insects and their eggs. The presence or absence of humidity is not apparently of much importance if this degree of heat is maintained. The superheating of houses in summer or during other favorable climatic conditions, from 115 degrees to 130 degrees Fahrenheit is practical, will not affect household materials and equipment, and is most effective for the destruction of insects. Clothing and other materials, that may be infested with either insects or their eggs, by being exposed in rooms for an hour at a constant temperature as indicated, or being boiled in water, if practical and convenient, or if exposed to the heat of hot irons, as in the process of laundering, will be quickly rid of these pests.

In this connection, mention may be made, that the liberal use of hot water or live steam is a very effective method for the destruction of both the active insects and their eggs. This may be used providing there is no danger in affecting furniture, fabrics, and other materials it may come in contact with. It is especially

convenient for the destruction of bedbugs in beds made of material other than wood; ants in the home and garden; moth eggs on fabrics and clothing that will not be injured by water; roaches, etc.

The rays of the sun during the warm season can also be used to obtain the necessary degree of dry heat. The old-time custom of sunning clothing to kill clothes moths in fabrics is very effective and can be readily employed.

Storage.

The use of all kinds of cold storage, as a method of protection against injury by fabric pests of all kinds, is practiced extensively today. It is employed by dealers in upholstered furniture, blankets, curtains, robes, carpets, furs, woolens and other merchandise. Cold storage rooms or warehouses are today a part of the equipment of all well conducted business enterprises. The temperature that is maintained is rarely below 40 degrees Fahrenheit. It should be said that this temperature, if maintained constantly, will protect articles only during the period of storage. If the clothing or articles were not cleaned, brushed or aired thoroughly as they should have been, any larvæ, especially of moths, which may be present will not necessarily be destroyed, but they remain inactive and incapable of causing injury. If refrigerated only for a few months, the larvæ in the clothing after removal from cold storage and subjected to warmer temperature generally die, but they may be found to become active.

If the storage concern not only guarantees to protect articles during the period of storage, but also aims at the destruction of clothes moths in the articles intrusted to them, the latter generally are cleaned thoroughly and usually exposed suddenly to a number of changes of temperature, placing them first in a refrigerator for a number of days and then they are suddenly exposed for a short period in a warm room, returned again to the refrigerator, again to the warm room, and finally to the storage proper. These sudden changes from cold to warm temperatures and the reverse have been found to be effective in the destruction of all moths and many of the other forms of insect life.

There are some merchants that are selling upholstered furniture, and clothing made of cloth, and wool in particular, which they claim are moth-proof. In some instances, a regular bond is distrib-

uted as a guarantee that the material is immune from moth damage. The raw material is treated by special processes, which is to protect this from the activity of the moths.

Inasmuch as the selling of material so treated is of recent occurrence, it is perhaps best to wait and see whether such treatment is effective. It appears to me, however, that it will be a difficult matter to prove before a court that holes in garments, etc., are ones caused by moths. It is also not so many years ago, since they began to treat posts, and in fact all timber to be used for similar purposes, with chemicals, in order to prevent attacks of such wood by various pests. Today we know that this method is only partially effective, and that the timber, even though chemically treated, may be eventually destroyed by these pests boring in them. It is true that the average life of a garment is of comparatively short duration, but nevertheless, we will have to wait for Mother Time to show and tell us whether chemical processes will keep cloth and similar material immune from moth damage.

The layman is familiar with the so-called "Moth-Proof" Bags that appear on the market. They are employed for the storage of all kinds of wearing apparel, etc. Some of these are impregnated with an odor of tar or other volatile agents. The latter have no distinct advantage, other than imparting an odor in the closet or storage room. All types of paper are used, heavy, light, colored, etc.

It may interest you to know that any ordinary strong wrapping paper or even several thicknesses of newspapers are just as satisfactory. The value of bags or paper as protectors against infestation, especially by moths, is in the fact, that moths do not eat paper to get into clothing, carpets, etc., that may be wrapped tightly. Care must be observed that bags or other wrappings are not torn or unsealed, or that the folds of these are bent back, otherwise moths may crawl or find their way into the bundle.

"Moth-Proof" paper bags or tight wrappings do not kill moths. It is therefore of great importance to be assured that all articles, laid away, are first freed of moths and their larvæ. Frequent brushing, cleaning, beating and aeration in the sun or even dry cleaning, if necessary, should be practiced. Special care should be given to the brushing of all seams, pockets, crevices, etc., during the cleaning of such material. These then should be protected by being

wrapped in paper, or placed in tight chests, or sealed boxes, and exposed in any place without danger of infestation from without.

Hats, clothing, furs, and other articles can be protected by cleaning and then placing them in unbroken cardboard boxes, suit or hat boxes, etc., and sealing the covers with adhesive tape or with gummed paper.

The average trunk or chest is not tight enough to keep out moths. Cedar chests, generally, if well constructed are unusually tight. The characteristic odor, which is present, is due to a volatile oil, which adds to the efficiency of these chests, as it possesses some insecticidal value. It is however important that clothing, furs, skins, pillows, carpets, etc., should receive the same careful preliminary treatment before storage, as advised in preparing materials for wrapping, or to be placed in bags.

Storage places as made in the home, in attics, basements, cellars, sheds, or in empty rooms should be orderly arranged and care observed in frequently removing dust and dirt. All windows and other openings should be screened and the compartments should be ventilated at frequent intervals. All boxes or packages, in which materials are wrapped for storage, should be preferably placed on racks or shelves raised from the floor. Newspapers, magazines, and other articles, which tend to absorb moisture and therefore imparting dampness to the environment, should not be kept around the house. If needed, they should be stored in tightly covered compartments.

Insecticides and Fumigants.

Undoubtedly the most efficient remedy for the eradication of the many insect pests (and their eggs), mentioned, is to fumigate the house or rooms with hydrocyanic acid gas. This fumigant (*i. e.*, gas or vapor used to destroy insects) has very little effect in the destruction of bacteria, but is the best insecticidal fumigant, and acts as a standard remedy against household insects. I might add that rats, mice, and most all types of insect and animal life are also killed by its use. It seems to have the peculiar and fortunate property of causing all forms of animal life to rush forth from their hiding places, so that there is very little, if any, annoyance caused by the dead insects or animals putrefying in environments of the home that cannot be reached. If pure materials are employed to generate the vapor (generally a mixture of sodium cy-

anide and sulphuric acid), the resulting product will not tarnish metal or bleach furnishings.

This gas is extremely poisonous, and is fatal to human beings, if inhaled. This is the same gas, which, as the so-called "Lethal Gas," was employed during the early part of February of this year to execute a prisoner, condemned to death, in the State of Nevada. One is therefore cautioned not to undertake this process of fumigation, unless it is understood in every particular. The careless and uneducated layman should not attempt its use. It is merely mentioned here, so that you may know of its action, and if all other methods fail to rid an infested home, then Hydrocyanic Acid Gas should be employed by an experienced worker, one who may be sent by any of the many Boards of Health, Sanitary Commissions, or private exterminating concerns.

When this gas is employed, all humans and pets should leave the home. If the latter is attached and loosely constructed, it may be best to advise the neighbors to vacate their premises for a few hours or until the process is completed. All fires should be stopped immediately before fumigation is commenced. Liquids, moist foods or anything that might absorb the dry gas should be removed. At least six, but preferably twelve hours are required for the gas to do its work.

The fumes of burning sulphur have also been advised as an efficient agent in eradication, providing the technique that is employed is thorough and complete.

The directions, which are more or less general ones, are to be observed not only here but when using any fumigant. They are:

(1) Determine the cubic capacity of the room or rooms to be treated obtained by multiplying the length, by width, by the height, Use a proportionate amount of material. In the case of sulphur fumes, three pounds of powdered sulphur are employed for each 1000 cubic feet of space. A hot coal, a little alcohol or benzine, placed in a depression made in the top of the sulphur is employed to start the ignition of the latter. The sulphur candles, which have a wick, can be used, wherever available. Failure with sulphur candles is often reported. This is due to the fact that a few candles will not be satisfactory to treat an environment, where more are required. Remember the amounts required for each 1000 cubic feet of space.

(2) Arrange for the opening of doors and windows from the outside, so as to allow the gas to escape at the conclusion of fumigation.

(3) Close all ventilators, registers, fireplaces, and other openings, and seal all crevices and openings, either with cotton, waste rags or papers and adhesive tape. The door at the exit is treated from the outside, after the fumigation is started. This is done to prevent the escape of the gas during fumigation.

(4) Cupboards, bookcases, drawers, etc., should be opened, and all articles should be thrown about loosely, so that the gas may reach them.

(5) Select the proper vessels in which the gas is to be generated. Shallow iron pots, three to six inches high and one to two feet in diameter, are preferably used to hold powdered or coarsely broken stick or lump sulphur. It is advisable that these vessels should be placed on bricks, the latter in turn extending out of water placed in a wide shallow basin or tub.

(6) Allow a clear passageway to the door, so that the workers will be able to leave quickly.

(7) The fumigant should be allowed to act for at least twelve and preferably twenty-four hours.

Fumigants are only effective if all the above directions are carefully observed and executed. It is my personal opinion that the laity rarely employ this technique with the required degree of care. On this account, fumigation in the hands of laymen is in many cases of little value as an effective measure for the eradication of household pests. It might be of interest to note, that the fumes of burning sulphur will tarnish metal and if moisture is present, as may be if the humidity is high, furnishings and other equipment will be bleached. An opinion seems to prevail among some, that the eggs of roaches and even bedbugs may not be destroyed by fumes of sulphur.

Many seem to be impressed with the fact that Formaldyhyde Gas, being the most efficient, practical fumigant employed to destroy bacteria, will also be effective against insects. This is an erroneous view, AS FORMALDEHYDE GAS WILL NOT KILL THE COMMONLY OBSERVED HOUSEHOLD PESTS. If in non-inhabited dwellings, formaldeyhde gas is to be employed to kill bacteria, and sulphur or hydrocyanic acid gas is to be used to destroy insects, both

gases are not to be generated at the same time. One gas is to be allowed to act, and then after a lapse of twenty-four hours, the other gas is generated.

Other gases or vapors have been experimented with, and are being employed by some to assist in the eradication of many of the household pests.

Carbon Disulphide Fumes have been advocated as an efficient remedy for the destruction of moths, roaches, ants, etc., especially in trunks, closets, and small tightly constructed rooms and compartments. From eight to ten pounds of the liquid are required for each 1000 cubic feet of space to be treated. Most all gases or vapors employed as fumigants are lighter than air. It is therefore only necessary to see that the gas is generated so that it may rise. Carbon Disulphide Gas is heavier than air. This gas must be generated by placing the liquid at the top of the compartment or near the ceiling of a room, and then allowing the gas to escape slowly. It then falls to the bottom, thus mixing with the air. Exposure should be for at least six to twelve hours. A temperature of at least 60 degrees Fahrenheit is required to obtain efficient results. The warmer the environment to be treated, the more effective will be the gassing.

Carbon Disulphide is only valuable and applicable if the vapor can be confined. The gas is explosive, and every precaution should be taken to see that no fire is in or around the environment during the treatment. If a sufficient quantity of the gas is inhaled, various ill effects become apparent. The result may not only be merely that of suffocation, but distinctly poisonous in an operator who persists in remaining around the premises when dizziness has developed. The vapor also seems to have an effect upon heart action, and individuals having any heart condition are therefore cautioned against using or being present when this gas is employed.

Carbon Tetrachloride has been advocated as a substitute for the Disulphide. Like the latter, the gas is generated by allowing the liquid carbon tetrachloride to volatilize, by being exposed in dishes at the top of the compartment. The gas is heavier than air, is neither inflammable nor explosive, and does not possess the irritating and poisonous properties characteristic of the fumes of carbon disulphide. It is however only about one-half to one-third as effective as the latter. One would therefore have to use from twenty

to thirty pounds of carbon tetrachloride for each 1000 cubic feet of space. Though effective, this would make such fumigation very expensive.

Vapors generated by burning powdered Pyrethrum Flowers or Insect Powder are said to be very effective for the eradication of roaches, mosquitoes and occasionally fleas. The technique to be used is identical as that employed when using sulphur fumes as a fumigant. The fumes seem to stupefy the insects, and the latter can then be swept up and burned.

Fumes from strammonium or Jimson weed, Cresyl, equal parts of camphor and phenol (known as Mimms Culicide), and even dried orange peel are sometimes used as fumigants to assist in the eradication especially of mosquitoes.

Powdered Jimson Weed, 8 ounces to each 1000 cubic feet of space, to which is added one-fourth of its weight of saltpeter (so as to make it burn more readily), will produce fumes that are non-poisonous to humans, will not injure furnishings or metals, and is said to be effective against mosquitoes.

Fumes produced by burning four ounces of camphorated Phenol (equal parts of camphor and crystal Phenol or Carbolic Acid) to each 1000 cubic feet of space, in closed compartments, have been found effective in destroying flies and mosquitoes.

All the fumigants mentioned thus far as only effective providing the general regulations as given for fumigants are adhered to.

The fumes of cresyl (obtained by burning one of the coal tar products), and of dried orange peel are of value as deterrents, rather than as destructive agents, against mosquitoes. By burning these, fumes are produced that are non-injurious to humans, do not affect household goods, and their work of driving mosquitoes away is performed without having the rooms vacated, and can be used to burn at night in one's sleeping quarters.

Disinfestation or the ridding an infested dwelling of insects should proceed in an orderly fashion. The layman generally practices this spasmodically. A workable scheme is only successful, if executed systematically and continuously, after familiarizing oneself with the habits of the insects to be exterminated and obtaining a knowledge of the method to be employed in disinfestation.

Many of the household insect pests display great intelligence in avoiding poisonous baits, traps, and in general seem to be more or

less endowed with the ability to avoid or guard against their enemies. On this account, baits, traps, etc., will not always accomplish the desired work expected of them. Temperature control methods are desirable, but are not used frequently. Fumigation is of value only in the hands of an experienced or careful worker. It therefore remains for the layman to depend extensively upon the proper use of contact insecticides. The latter are powders or liquids, which are capable of killing insects, when brought in contact with their bodies.

Bactericides or germicides are chemicals or drugs or solutions of the latter that will kill bacteria.

Deodorants are chemicals or drugs that will remove impure or obnoxious odors.

An insecticide may or may not be a germicide, and in like manner, it may or may not be a deodorant.

Hydrocyanic acid gas and coal oil (kerosene) are very efficient insecticides, but they are not bactericides. Formaldehyde is an efficient bactericide, also a deodorant, but it is not an insecticide. Incense and perfumes are deodorants, but are neither insecticides nor germicides. Carbolic acid, and cresol, on the other hand, are examples of chemicals that are bactericides, insecticides and deodorants.

In the selection of an efficient insecticide, the question is generally asked whether a powder or a liquid is to be preferred. It is not always possible to give a correct answer. One would really have to know the particular pest for which the preparation is to be employed, as well as the environment which is to be treated. It may however be said that wherever possible and practical, a liquid insecticide should be used first, and then followed by a powder. The former can be sprayed or dropped into cracks, crevices, etc., and because of a free flow or a vapor that may be produced, a greater surface can be reached. Due to the rapid evaporation of liquid insecticides, they should be applied freely and frequently. In applying them, one should be sure that a large surface is reached. Spraying or squirting is only to be employed, when mopping or the application of the insecticide with a paint brush cannot be used. Many efficient insecticides are frequently proclaimed as worthless by individuals, who employ a faulty technique. As an example, less of an insecticide would be required to rid a bed of bedbugs, if the

preparation was applied with a brush. With such technique, one would be sure that all slats, tufts of mattress, etc., were reached. On the other hand, spraying or squirting, is but a guess affair; you may or may not reach all parts, where insects and their eggs may be and in addition there is greater waste of material. In like manner, floors, drawers, etc., can be treated best by painting, mopping or wiping the infested area with a cloth or brush moistened with the liquid insecticide.

Kerosene or coal oil, benzine, gasoline and Carbon Disulphide in their order named are the most effective and most frequently used of the liquid insecticides. Care must be taken that these are employed in such places that they will not be a fire hazard.

Carbolic Acid or still better Cresol, a liquid obtained in the destructive distillation of coal tar, can be added to the extent of from one to five per cent. so as to make a more effective and useful solution. Some have advised adding about ten or fifteen per cent. of turpentine to the coal oil or kerosene before adding the cresol. Turpentine is not only in itself an effective insecticide, but will disguise somewhat the coal oil odor.

Kerosene oil may be employed to destroy mosquito larvæ in stagnant pools by covering the surface of the latter with a thin film of the oil, or to be exact using one fluid ounce of kerosene for each fifteen square feet of water surface. This film is to be replaced after the coal oil evaporates. This procedure is to be carried out if the standing water, whether in a pond, swamp, etc., cannot be drained or filled in.

Many of the liquid insecticides on the market, which are sold under various trade marks and fancy names, are essentially nothing more than kerosene, to which may be added cresol or a closely related chemical, and the coal oil odor is disguised by the addition of any one or a mixture of the following oils, which in most instances possess some insecticidal properties themselves: oil of mirbane, oil of sassafras, oil of Eucalyptus, oil of camphor, oil of wintergreen and oil of pine. There is this, however, to be said on behalf of these marketed products; that the coal oil used is generally of a grade which is known as water white, and also one which possesses a high flash point. This is somewhat different from the grade of coal oil bought at the corner grocery store. The latter generally can become ignited at a lower temperature and most fre-

quently leaves a stain, when applied to clothing, etc. The water white grade generally is stainless, an effect especially to be desired if clothing, rugs, etc., are to be sprayed with a liquid insecticide.

Strong solutions of Bichloride of Mercury have been advocated and recommended. Either a saturated solution of Bichloride of Mercury in denatured alcohol or a mixture of denatured alcohol and turpentine or a solution consisting of the following formula have been proclaimed as an efficient insecticidal preparation, especially for bedbugs.

Bichloride of Mercury	2 ounces
Table Salt	2 ounces
Water	½ pint
Denatured Alcohol	½ pint
Turpentine	1½ pints

This preparation, I have found very efficient in ridding cellars, garages, and similar environments of fleas and their eggs by mopping the floors, walls, etc., thoroughly with this solution. Care should be taken when using this solution, as it is very poisonous.

It cannot be impressed too often that the liquid insecticides are to be used liberally; and are to be introduced freely by painting with a brush or mopping with a cloth wherever such procedure is practicable. No place is to be overlooked during the treatment, especially if there is a thought that these pests or their eggs may be present.

It is advisable that the operation, which is employed, should be repeated at intervals of four or five days, for at least three successive applications, so that any eggs that may have hatched during the intervening period may be destroyed.

Instead of kerosene, water has been used to make a solution of Bichloride of Mercury, Carbolic Acid, and a mixture of soap and water has been used to dissolve Cresol. These watery solutions have been advocated as efficient insecticides.

Various powders, as insect powder, etc., have been macerated with coal oil and to the resulting mixture, after filtration, there has been added one or more of the volatile oils to destroy the coal oil odor. There seems to be no added value to such preparations over plain kerosene, other than an increase in cost.

The destruction of fleas on domestic animals is often necessary to do away completely with infestation by the latter. A solution

made by adding two teaspoonfuls of lysol, creolin or a similar miscible coal tar product to a pint of warm water may be employed as a wash to rid a host of fleas. This solution should be worked into the hair with a brush, care being taken that the entire body is reached, and that the eyes are protected.

As good a remedy as the foregoing is a kerosene emulsion. This is made by dissolving about a teaspoonful of washing soap shavings or soap chips in a quarter of a glass of hot water. When this is brought to a boil, it is removed from the fire, and about two and one-half teaspoonfuls of kerosene are added. This is agitated rapidly, preferably with an egg beater. The kerosene will dissolve in the soap solution. If it should not dissolve, further heating, after placing the mixture in a pan of boiling water and additional agitation will be necessary. Enough water is then added to make a quart of the kerosene emulsion. Straight kerosene should never be used on animals as it will burn them.

After the animal has been washed for about ten minutes in any one of the previously named solutions, they are removed and dried.

In the case of pets, as cats, that are tender-skinned, the preparation should be washed out of the fur with soap and water immediately, after the animal is removed from the chemical bath, and then dried.

Of temporary value in infested places is the use of a number of substances, that are known as repellants. The latter act by driving the insect away, rather than destroying them. Oils of Pennyroyal, Eucalyptus, and Wintergreen, etc., smeared on clothing, wearing apparel on or around beds, etc., are said to be efficient for the driving away of fleas.

Oil of Peppermint, Oil of Tar, Oil of Citronella, Oil of Pennyroyal, Oil of Lavender, Spirits of Camphor, Oil of Cassia, etc., have been recommended as efficient remedies to be applied on one's person, on screens, around beds, or in environments where mosquitoes are abundant, so as to drive them away. Some of the oils mentioned have been recommended as repellants against flies, when the latter become an annoyance in a particular environment.

There are many powders that will be mentioned that are also used as repellants.

It has been my personal observation, that by opening your program in the eradication of insects by first using a heavy spray or

application of a cresol kerosene mixture, more insects are brought to light than were thought to be hiding. The spray is dangerous to them as it poisons their food and the air in their immediate environment. Bedbugs, roaches, fleas, and other insects that are thus driven into the open from their places of concealment can be killed in a few minutes, by applying the spray directly upon them. It is now best to follow up this work by using a powdered insecticide, which will act as an internal poison, or probably clog up their breathing passages, eventually killing those that remain. This powder should be sprinkled in places, where it can be left undisturbed for a long time. It should be blown or sprinkled about by means of a blower, dust gun or dusting box in cracks, crevices, corners, on shelves or anywhere where the insects are likely to crawl.

There are many pests which cannot be reached by powder insecticides, as it is difficult to get these powders into the places where the insects may be found. This is especially true when trying to employ them in the eradication of bedbugs, and those insects that are always on the go, as flies, mosquitoes, etc.

One of the most simple and effective powder insecticides is Commercial Sodium Fluoride. This chemical forms the basis of most roach powders on the market. It is either used undiluted, but most frequently there is added an equal quantity of some inert substance, as flour, etc. Employed as a dusting powder in or around cracks, crevices, closets, etc., this powder, if used persistently, with frequent and free applications, will eventually rid badly infested environments of roaches. It has been claimed that Sodium Fluoride scattered frequently and freely on floors or blown about in infested places, will be found to be somewhat effective against fleas and other insects, as it has against roaches and ants.

Persian Insect Powder, known also as Insect or Pyrethrum Powder, is another common remedy, which has been employed to assist in insect eradication. Its use as a fumigant, as an effective remedy against mosquitoes, was mentioned. As sold or as stored around the home, Pyrethrum Powder may become stale, and then possesses little or no value. When fresh, it is at best a repellant, and relief with its use can only be obtained if it is liberally and frequently applied. Some observers have advocated the sprinkling of this powder on floors, after coal oil, or cresol and coal oil, have been used, so as to assist in the eradication of fleas. It has also been claimed by some if this powder is fresh, it will destroy the larvæ

of moths in clothes if the latter are thoroughly dusted with the powder, and then placed in a tightly constructed chest or trunk, or wrapped well in unbroken paper.

Borax also enters into the composition of many insect powders, especially roach powders, and this is to be used, as all other powder insecticides. A mixture of Sodium Fluoride, containing about 10 per cent. of Borax, some flour, and a small percentage of sugar or powdered chocolate will make an ideal powder to be used for general insecticidal effect.

Moth Balls or Powdered Moth Balls, commonly known as Flake Camphor and scientifically known as Naphthalene, is a well known substance employed for protecting materials against injury by moths and carpet beetles. A chemical similar in appearance to the latter, which is just as effective, but somewhat more expensive, is being used in some quarters as a new remedy in moth control. This is known as Paradichlorobenzene. Lump or Gum Camphor is used in the same manner, as the previously mentioned powders, but, strange to say, is in reality less effective.

To get results from the use of these three powders, they must be used in tightly closed containers or environments. The fumes given off by slow evaporation must be confined, for if allowed to escape, its value is but limited, and generally is then only partially effective. At least one pound of these powders should be used to each ten cubic feet of space. If there is a possibility of the fumes escaping, as would be the case in loosely constructed drawers, closets, chests or trunks, from two to three times the amount given should be used.

If carpet beetles persist beneath carpets or rugs, upholstered furniture, etc., the use of these powders cannot be depended upon. The best thing to do, if possible, is to fumigate with Hydrocyanic Acid Gas, Carbon Disulphide, etc., or one may repeatedly apply kerosene in the crevices and cracks of the infested areas.

Flake Camphor rubbed in the fur of domestic animals will stupify and destroy fleas, that may be present. There seems to be no ill effect caused to the pet, except at times the animal may be made ill for a day or two.

One of the best ways in ridding an infested home of fleas is to sprinkle or scatter at least five or more pounds of Flaked Naphthalene over the floor of an infested room. The latter is to be kept tightly closed for at least twenty-four hours. After this period, the

flaked camphor may be swept into another room, which is to be treated. This is very effective for the destruction of all adult and larval fleas. It is best to be sure that all eggs have been destroyed, by then washing the floor with one of the following, either kerosene, kerosene to which has been added cresol, a weak solution of Bichloride of Mercury or hot soap suds. After the floor coverings are thoroughly aired and beaten, they should be sprinkled with either kerosene or freely with Alum, Pyrethrum Powder or Flaked Camphor. The free use of these powders is said to give very satisfactory results.

In conclusion, it may be noted that there are many references in various books, magazines, and other literature to the insecticidal action of other powders, either chemicals, drugs or powdered parts of plants. Powdered Allspice, Black Cohosh, Black Walnut, Boneset, Cayenne Pepper, Eucalyptus, Indigo Weed, Jimson Weed, Lavender Flowers, May Weed, Oleander, Pennyroyal, Quassia Chips, Red Cedar Leaves, Roman Chamomile, Sassafras, Tobacco, are but a few of the various powder insecticides that you may at times hear of. It may interest you to know the term "Insect Powder," when used without qualification and therefore when used for labeling, is under legal restriction, directed to be nothing more than the "Flower Heads of three particular species of Chrysanthemum," one being the Dalmatian Insect Powder and the other two, so-called Persian Insect Powders. As general insecticidal agents, the list of powders just mentioned are practically worthless, as are many others, which are exploited before the public. Some of them, however, may be found to be somewhat effective in special instances for particular types of insects. Many of them depend for their activity upon the presence or liberation of an active volatile ingredient. It is usually difficult for the layman to ascertain, whether the latter is or is not present, as generally, the activity of these substances is practically nil, unless fresh. These are therefore not to be recommended to the housewife, either because of a lack of definite information regarding their value, of only partial effectiveness, high cost, or impracticability of application.

Pain and irritation are frequently produced by the bites of mosquitoes, fleas and bedbugs. The susceptibility of some people to the effect of these bites is much greater than that of others. Some scientists seem to feel that the human susceptibility is not as big a

factor as the fact that there is a specific difference in the poison causing the irritation or inflammation, as given forth by the different species of the same insect.

In the case of bites, by ordinary mosquitoes, I recall having heard many a thoroughbred Jerseyman tell his summer guests that "when a mosquito bites you, don't interrupt her, let the mosquito get enough to satisfy her." He will go on further by telling that if the mosquito gets a full meal, an irritation or inflammation that may be produced will be less painful and less swollen, than would be the case if she was interrupted. It may appear strange, that this is to a large extent true. The belief for the correctness of this statement, lies in the probable reasoning that the poison which is at first deposited, is drawn back by the mosquito with the additional blood it takes as its full quota for a meal.

Various remedies have been recommended to alleviate the pain caused by these bites. Tincture of Iodine is applied will be of considerable benefit in many cases of bites by mosquitoes, fleas or bedbugs. Care should be taken that this should not be used on tender skins or by individuals having eczema. Carbolated vaseline, a 2 per cent. to 3 per cent. solution of Carbolic Acid, Lysol or similar coal tar disinfectant, household ammonia, glycerin, spirit of camphor, alcohol and peroxide of hydrogen have been enthusiastically recommended by various workers. All have their adherents, and it is not unlikely that their effects may vary, depending upon the insect or even species of insect that did the damage, as well as upon the individual who was the victim.

One of the best known entomologists in the country, Dr. Howard, has reported that he found that the most satisfactory remedy for mosquito bites was to rub moist toilet soap on the puncture, when the irritation will pass away quickly.

The demand for relief due to the unnecessary waste, trouble, and even hardship, caused by the pests mentioned, is becoming widespread and urgent. A campaign of education to demand or to increase public intolerance to these pests will assist greatly in organizing worthy, practical, sane, and united attempts in the eradication of these insects. It is the writer's fond wish that all who read this may be impressed with the importance of the topic, and that they will do their share in getting rid of these pests, which always bespeak repulsiveness and dislike, wherever present.

CHEMISTRY IN AND ABOUT THE HOME.

By Freeman P. Stroup, Ph. M.

In our everyday life we are constantly in touch with chemical processes. Our very bodies are chemical factories, so to speak, in which are going on, day and night, year in and year out, without vacations or "time off" for any purpose, chemical processes of building up and breaking down, all vital processes being accompanied by chemical changes. When life ceases it is because the synthetic processes in the human factory can no longer take care of the raw materials brought into it nor the by-products formed in its operation. It ceases to function as a productive organization for the benefit of mankind, and like a man-made factory which is no longer of use in the world, it begins to decay and, sooner or later, as the result of other chemical processes, the complex substances of which it was built will be resolved into simpler ones and made a part of "the dust of the earth."

In our workshops, on the farm, in the home—everywhere we go—there are constantly going on chemical processes which make for our happiness or unhappiness; and it is of some of these that I wish particularly to speak this evening. Just at this season of the year (late in November), with cold weather at hand or not far off, and the price of coal, our chief fuel, nearly out of the financial reach of many, a discussion of some of the problems arising from the heating of our homes, places of business and amusement, would seem to be of very general public interest; so, as the subject is a large one, I shall confine myself chiefly to that phase of everyday chemistry. Perhaps, at some future date, there will come an opportunity to take up the chemistry of the kitchen as it applies to cooking, baking, cleaning, etc.

Fuels.

Fuels are substances which burn more or less readily in air, producing heat cheaply enough to permit its use for industrial and domestic purposes. In this part of the country (eastern Pennsylvania) the chief domestic fuel is anthracite, often called "hard coal." Some bituminous coal (so-called "soft coal") is used, mainly, how-

ever, for industrial purposes, and, in recent years, both kinds of coal have been replaced, to some extent, both for industrial and domestic purposes, by "fuel oil" (sometimes a crude petroleum and sometimes a by-product in the manufacture of other petroleum products). Domestically, these are burned largely in furnaces (usually placed in the cellar of the home) and, to a lesser extent, in small heating stoves, cook stoves or ranges. Gas, kerosene (locally called "coal oil"), and occasionally charcoal and coke are used in stoves designed for heating small rooms and in ranges for culinary purposes. Gasoline is only occasionally used, as most people are justly afraid of it because of its volatility and the ready inflammability of mixtures of its vapors and air. Alcohol (generally "denatured") finds some use in the heating of samovars, chafing dishes and other apparatus which it is desired to heat for only a brief space of time. In this section wood is too expensive for general use as a fuel, but waste wood finds wide use as a kindling material for less easily ignited substances.

Chemical Composition of Fuels.

Chemically, charcoal, coke and anthracite are chiefly carbon, while bituminous coal is largely carbon with varying amounts of compounds of carbon and hydrogen (so-called hydrocarbons). Gasoline, kerosene and fuel oil are complex mixtures of hydrocarbons, while wood is mainly cellulose and lignin, both being compounds of carbon, hydrogen and oxygen. Natural gas, much used in some parts of the country, is a varying mixture of gaseous hydrocarbons, while "gas" (as manufactured and sold in most communities of any considerable size) is a mixture of hydrogen, hydrocarbons and carbon monoxide. Alcohol is a definite compound of hydrogen, carbon and oxygen, to which the chemist gives the formula C_2H_5OH, and wood alcohol, used for denaturing ordinary alcohol, and also in the more or less pure form for small lamps, often sold under trade names, while a carbon-hydrogen-oxygen compound, has been given the formula CH_3OH. Doubtless, you will have noted that all of the substances used as domestic fuels contain carbon and most of them hydrogen.

Chemistry of Combustion.

When hydrogen burns it is because it combines chemically with oxygen (which constitutes about one-fifth of the air by volume), the product of the combination being water (the chemist often writes it H_2O) in the form of vapor. If we hold an inverted cold glass vessel (a tumbler or goblet will do very nicely) over the flame of burning gas, gasoline, kerosene, alcohol, wood or a candle, we soon observe a cloudiness on the inner surface of the vessel, due to the condensation of some of the water vapor formed in the combustion of the hydrogen of the burning material. Again, who among us has not noticed, as some time or other, when a vessel (a teakettle, for instance) filled with very cold water was put over an open gas fire, that the bottom got wet in a few minutes, sometimes wet enough to cause a drip into the fire, and who has not on such occasions been fearful that the vessel had "sprung a leak"? In the future don't worry—the drip only represents condensation of water vapor formed in the burning of the hydrogen of the gas. The richer the gas in hydrogen the greater will be the amount of water formed. Yet again, when liquid air in a kettle is put over the open gas fire the cold produced in the evaporation of the liquid air is so great as not only to condense the water vapor to the liquid form but also to freeze it solid, so that we see the curious spectacle of ice forming in direct contact with a flame from gases produced in the flame. The amount of heat liberated in the burning of hydrogen is very great and, in a general way, we can say that the larger the percentage of hydrogen, either free or combined, in a fuel, the greater the heating value.

When carbon burns it is because it combines chemically with oxygen to form an oxide of carbon, with the liberation of a considerable amount of heat. There are two of these oxides of carbon—carbon monoxide (CO) and carbon dioxide (CO_2), the latter containing twice as much oxygen as the former in proportion to the carbon. In the formation of carbon monoxide less than one-third as much heat is developed as when carbon dioxide is formed, perhaps the most important fact for all users of fuel to remember, particularly as the formation of the latter instead of the former means, ordinarily, only the supplying of a little more air to the burning fuel, and air is still "free."

Heating Values of Fuels.

The heating value of a fuel may be expressed in several ways, *viz.:*

(1) The small calorie ("calorie," abbreviated "cal."), which represents the heat required to raise the temperature of one gramme of water one degree Centigrade;

(2) The large calorie ("Calorie," abbreviated "Cal."), which represents the heat required to raise the temperature of one kilogramme (1000 grammes) of water one degree Centigrade;

(3) The British thermal unit (abbreviated B. T. U.), which represents the heat required to raise the temperature of one pound (avoirdupois) of water one degree Fahrenheit.

One (1.0) degree Centigrade (C.) is equivalent to 1.8 degrees Fahrenheit (F.), and 1 kilogramme (Kgm.) is equivalent to 2.2 pounds (lbs. av.), hence 1 Cal. (1.8 x 2.2) is the equivalent of 3.96 B. T. U.

The approximate heats of combustion of the common fuels, and of some other substances mentioned in this lecture, are as follows:

	B. T. U. per Lb.	Cals. per Kgm.
Hydrogen	62,000	34,462
Carbon (to Form CO)	4,450	2,475
Carbon (to Form CO_2)	14,600	8,100
(Coke and Charcoal Are Mainly Carbon.)		
Carbon Monoxide (CO)	4,370	2,425
Methane (CH_4)	24,000	13,300
(Methane is the Chief Constituent of "Dry" Natural Gas, and a Constituent of Many Varieties of Artificial Gas.)		
Gasoline (Average, C_6H_{14})	16,340	9,080
Kerosene	18,000	10,000
Alcohol (C_2H_5OH)	12,700	7,000
Hard Wood (Oak)	8,300	4,600
Soft Wood (Pine)	9,150	5,100
Bituminous Coal	14,440 to 15,300	7,500 to 8,500
Anthracite	15,650 to 15,800	8,700 to 8,800

	B. T. U. per Cubic Foot
Natural Gas	900 to 1,135
Coal Gas (From Distillation of Soft Coal)	500 (Average)
Water Gas (Chiefly Hydrogen and Carbon Monoxide)	300 (Average)

Reduced to simple figures, the relative heating values of the common fuels, based upon the amount of heat produced from a unit weight of substance burned, is, roughly, as follows: Hard wood, 9; soft wood, 10; soft coal, 15 to 17; coke and charcoal, 16; hard coal, 17.5; kerosene, 20; fuel oil, above 20; natural gas, as high as 40, depending upon composition.

The consumer who wishes to make comparisons of various fuels as to heating values and costs is confronted with a number of difficulties. The heating values are generally based upon the combustion of unit *weights* (gramme, kilogramme or pound avoirdupois), but liquid fuels (gasoline, kerosene, fuel oil) are generally sold by *measure* (gallon or barrel), gaseous fuels (natural and artificial gas) are sold by the *cubic foot* or a multiple of it, wood is sold by the *cord* (which term, by the way, does not always mean the same amount of wood, either by weight or by volume), hard coal is sold by the "long" ton (2240 pounds), coke and soft coal are sold by the "short" ton (2000) pounds, or by the bushel, and charcoal is generally sold by the sack.

Efficiency at the Furnace.

In the use of charcoal, coke or anthracite, firing and the regulation of drafts has to be very carefully done, if one is to avoid sending a lot of the heat units of the fuel "up the flue" in the form of carbon monoxide, which, as intimated heretofore, represents only a stage in the combustion, and the formation of which develops less than one-third of the total possible amount of heat. It is practically impossible to burn anthracite in a furnace without first forming this gas, but it is possible to burn it at once to the higher oxide (CO_2), thus getting the full heating value of the coal, and it is almost a crime not to do so. All that is necessary is to provide for a sufficient influx of air over the fire to furnish the oxygen needed for this second stage of combustion. There are numerous devices on the market, some sold at exorbitantly high prices, intended to be fitted to the fire-door, through which a regulated supply of air is to be allowed to flow and be delivered over the fire-bed, but these are not necessary. Most furnace and stove fire-doors are provided with openings for this purpose, and fitted with wheels or slides by which the inflow of air may be regulated. Some furnaces have a special small door below the fire-door and above the ashpit door, designed for this purpose. The main thing to guard against is that

of allowing too great an inflow of air, in which case the excess of cold air chills the hot gases formed by the fire, lowering the efficiency of the furnace just that much. When the operator can see blue flames emerging from the spaces between the pieces of fuel he may be sure he is burning the carbon monoxide formed by the action of the oxygen of the draft air on the coal within the fire-bed, and is probably getting out of the fuel its maximum heating value—particularly if the blue flames are relatively long. Very short blue flames indicate too great an air supply over the fire. The writer of this paper has seen booklets issued by associations of coal producers or dealers, purporting to instruct users how to get the maximum value out of the coal they use, in which they were instructed always to keep the fire-door tightly closed, except while firing or when it is desired to check the fire. He has wondered whether they really believed what they were saying or whether what they said had any bearing on the fact that they had coal to sell.

In the burning of soft coal, natural gas, artificial gas, gasoline, kerosene and fuel oil, whose constituents are either wholly or partly hydrocarbons, one problem is to so control the air supply that there shall be complete combustion and no formation of soot, which is unconsumed carbon, and which, to the extent that it is produced, represents heating possibilities unrealized. When hydrocarbons burn they seem first to break up, in part at least, into elemental hydrogen and carbon, respectively. The ignition point of a mixture of hydrogen and air is low, so it promptly burns, but the ignition point of carbon (even in a finely divided form) in air is relatively high, and frequently much of that which is formed cools to below its ignition point before it comes into contact with oxygen enough to burn it. Result: smoke or soot, which not only represents fuel lost, but is something which, by coating the heating surfaces of pipes and drums or tubes, makes them poor conductors and prevents them taking up the heat from the gases which are brought into contact with them. It often clogs flues wholly or in part and interferes with the drawing of the heating system. If it gets out into the open air it becomes a nuisance to the neighborhood and seriously disturbs the peace of mind of the housekeeper who likes to see and keep things in a spick and span condition of cleanliness. Housewives compelled to live in communities where soft coal is improperly burned ought to have special consideration shown them in

the Day of Judgment. It is a very vigorous type of religion that will keep one from getting sorely "peeved" when a shower of soot from a neighboring chimney or a passing locomotive stack settles on her beautifully white "wash" on a Monday morning, or any other day of the week, for that matter. Statisticians have figured that the cost of keeping even moderately clean the homes, apparel and persons of individuals living in the smoke-begrimed communities of the country is an enormous one. Physicians tell us that many respiratory troubles are caused by the inhalation of soot, and physicists tell us that the heavy fogs that characterize the atmosphere of many of the world's large manufacturing centers are due to the condensation of gaseous moisture on small particles of soot, instead of its remaining in gaseous form and intimately mixed with the other gases which make up the atmosphere.

In firing with soft coal the furnace fuel bed should not be completely covered over with fresh fuel. If the fire-box is of such shape as to permit it, the fresh fuel should be placed just inside of the fire-door so that the gases promptly liberated will have to pass over a hot part of the fire on their way to the chimney. If a proper supply of air is allowed to mix with them the mixture will ignite and a maximum degree of combustion will be attained, with a maximum amount of heat generated. The same procedure is also good in firing with anthracite. Before adding fresh fuel, the burning coal just inside the fire-door should be pushed back toward the center of the fire-box, or even farther. Frequent firing with small portions of fuel at a time makes for greater efficiency and economy than infrequent firing with larger quantities of fuel.

Correct Air Supply.

Stoves and furnaces are often inefficient because of an insufficient air supply, due to the operator trying to draw all the needed air from a rather tightly closed compartment (cellar, in the case of the furnace, or living room, in the case of the stove). Solid and liquid fuels require for their perfect combustion approximately 15,000 times their own volume of air; and gaseous fuels require from 4 to 10 times their own volume of air. In order, then, that a fire should have the correct amount of air it is necessary to provide fresh supplies of air to take the place of that which goes into the fire chamber.

Occasionally one sees a hot-air heating system in which the air for circulation through the hot-air ducts is also taken from the cellar of the house. Anyone who has ever tried to draw air or water out of a bottle or jug without allowing air to enter can readily understand why it is just as impossible to draw air for either draft or circulation purposes, or both, out of a closed cellar indefinitely. Fresh quantities of air must be supplied, either through special ducts leading to the out-of-doors or else through an open door or window. The open-door or open-window arrangement may appear to be the cheaper, but it has several drawbacks, especially in very cold weather. The entire air space of the cellar becomes chilled, making it decidedly uncomfortable for the furnace tender, and, if the floor above is not thoroughly insulated, making cold the floor surfaces in the rooms immediately above the cellar. The air-duct system is to be preferred, with one duct for fire-draft air and another for circulation air. Each should be fitted with a damper.

Heating Small Rooms.

During the winter season many people heat individual rooms with gas stoves (often without flue connections) or oil stoves, or, occasionally, charcoal stoves, generally without flue connections. When these work properly there is a formation of water vapor in the case of the first two and of carbon dioxide in the case of all three; but in closed rooms, particularly if they are small (such as bedrooms, bathrooms, small offices in warehouses, etc.), the oxygen in the room is soon used up in the combustion of the fuel, the flame gets dim and smoky (in the case of the gas or oil) and, after a while, dies out altogether. In the meantime, what of the person or persons in the room? The oxygen needed for respiration has been used by the fire and there has been put in its place carbon dioxide, at first, and, later, carbon monoxide, a gas which is a deadly poison, even when much diluted with air. Neither of these gases has an odor and neither supports life, so, whether the stove is working properly or not, there is formed a gas or mixture of gases which may cause death, or at least asphyxiation, without any warning whatever.

Persons who have been overcome with carbon dioxide generally recover normal health speedily after having been restored to consciousness, but it is not always possible to revive them. On the

other hand, persons who have been overcome with carbon monoxide are often a long time in getting well, if, indeed, they get well at all. Many of them die weeks, sometimes months, afterward because of the blood-poisoning effects of this gas, which, for this reason, is often designated "deadly monoxide gas," especially by newspapers. Every winter there are accidents from the use of oil stoves as sources of heat in unventilated rooms. The writer recalls at this time an incident of his school days. He was using a bathroom which was being heated by a small oil stove and lighted by a small oil lamp. Shortly after entering the room he noticed the light getting dim and smoke issuing from the oil stove. Suspecting the cause, he raised the window an inch or so and promptly both lamp and stove functioned properly. He dreads to think what might have happened to him within the next few minutes, had he not correctly divined the cause of the peculiar behavior of the flame of the lamp just when he did. In his time he has seen two rooms which had been smoked black in just a few minutes from imperfect combustion of kerosene oil, in one case in an oil stove, in the other case in a big oil lamp. In both instances the occupant of the room left it temporarily, closing the door after him, the windows having been previously closed. What each landlady felt, and probably said "under her breath," would not sound well in polite society or look well in print.

Every winter we read in our newspapers accounts of here and there a person being found dead in a room with the gas flowing from a stove or jet where there is no fire. The report usually states that "it is supposed that the victim of the accident bumped against the gas cock and unwittingly turned on the gas, or that he turned the cock too far in turning off the gas." I wonder if the true explanation is not more often this: The victim went to his room, turned on the gas and ignited it. The stove had no flue connection, the room was unventilated, the oxygen was soon burned out of the air and the fire died out, the gas flow, however, was not checked, the victim first became drowsy from lack of oxygen, lost consciousness from the effects of the carbon dioxide and carbon monoxide produced when the gas was burning, and was finally killed by the gas flowing through the open valve. Sometimes we read that the cracks around the windows and doors were found stuffed with rags or paper, and the immediate conclusion and coroner's verdict is "Suicide," though often nobody can suggest a

reason for the person wishing to go into eternity prematurely. I wonder how many times the stuffing of cracks was not done to keep out cold rather than keep in gas. I verily believe that many of these so-called suicides are only victims of their own ignorance.

In every instance where any kind of a stove, whether fitted with flue connections or not, is used to heat a room, provision should be made for an influx of air into the room to take the place of that used in the fire, and particularly so if there is no provision made for carrying the products of combustion to the outside. Experiments have been made at the Pittsburgh station of the United States Bureau of Mines to show to what extent air cracks around windows and doors affect the family coal bill, and dealers in window strips are using the results of these investigations to boost the sale of their wares; but we must not overlook the fact that burning fuels require plenty of oxygen for combustion and human beings require it for their respiration, and the air is the source of this gas. Air we must have. If we have tight joints at doors and windows we must open one or the other; if the windows fit loosely we may often keep them closed, if there is no fire in the room. The cracks may allow enough circulation for respiration and one or two gas lights. To most people the paying of coal bills is preferable to that of paying doctors' and undertakers' bills.

Dampness in the Home.

Flueless gas and oil stoves, when in operation, produce moisture because of the combination of the free and combined hydrogen in the fuel with oxygen from the air. Often a room thus heated resembles the steaming chamber of a Turkish bath establishment. This is particularly true where the fuel is natural gas, as can be stated by those who were among the users of this substance when it first came into general use as a domestic fuel in western Pennsylvania about forty years ago. Because it could be burned without smoke people thought flues an unnecessary expense. In the winter time, when doors and windows were kept closed, the houses became veritable "sweat boxes," the furniture swelled and warped, wallpaper got loose and fell from the ceilings or peeled off the walls, the windows were covered with sweat or ice most of the time, clothing became damp and uncomfortable, starched articles lost their crispness and often developed mildew, people "caught

cold" easily as the result of going out of doors after a season in the water-laden atmosphere of their homes.

Some moisture, the amount varying with the temperature, in the air of living quarters is necessary for our health and comfort, but too much is as bad as too little. The way in which heat and cold affect us is largely dependent upon the percentage of moisture (humidity, we call it) in the atmosphere. Cold, moist air is a good conductor of heat, while cold dry air is a poor conductor. That is why people in the mountainous sections of the State can stand temperatures of fifteen to twenty-five degrees below zero better than we Philadelphians can stand temperatures an equal number of degrees above zero. The dry air of their parts of the country does not carry away their bodily heat as rapidly as does the moisture-laden air of this section.

On the other hand, warm moist air retards evaporation of perspiration and its attendant cooling effect. Moist air at 68 to 70 degrees Fahrenheit seems warmer than dry air at 80. Put a pan of water on or under each radiator and save coal, taking care, however, not to allow the air to become excessively moist. Did you ever notice that persons who have respiratory troubles do a whole lot less coughing in moist air than when the air is dry, and that coughs are less "tight"?

Explosions.

Improper procedure in the ignition of liquid or gaseous fuels may give rise to explosions, and many fatalities have occurred because of ignorance or carelessness on the part of some one or more persons. Gas should not be allowed to flow into a stove unless there is a flame already there and at the point where the gas enters. Gas itself will not explode, as some people imagine, but mixtures of gas and air in a wide range of proportions will explode, hence the importance of not allowing the formation of such mixtures. As poor a mixture as one part of gas to fifteen of air may give rise to violent explosions in the case of some gases.

Gasoline should never be used to hurry a fire, and there would be many fewer graves in our cemeteries if kerosene (so-called "coal oil") had never been used for that purpose. Gasoline vaporizes at ordinary temperatures and the vapor is highly inflammable. Kerosene does not give off inflammable vapors at ordinary temperatures; in fact one can plunge an ignited match into it without danger.

But when used to hurry a fire it is often poured on heated coals which are giving off no flame. The heat vaporizes the kerosene and the mixture of vapors and air often ignites from a glowing coal and with disastrous results.

Kerosene lamp explosions are of decidedly less frequent occurrence than they were in times past, partly because of the increased use of electricity for lighting purposes, but mainly because the kerosene of the present-day market is more nearly free from the low-boiling point fractions which made the old-time product dangerous. Before internal-combustion engines created the big demand for gasoline this substance was a "drug on the market," really a nuisance to the petroleum distiller; and the temptation was to leave as much of it in the kerosene as could be left in and have the product comply with the laws of the several States as regards "fire test." If gasoline always had commanded a higher price than kerosene, as is the case now, there never would have been any reason for establishing a legal "fire test." Since the two have changed places as to price refiners have seen to it that everything that could be used as a gasoline constituent was removed from the kerosene, and today the tendency on the part of many is to leave or put as much kerosene in the gasoline as the mixer "can get away with." Users of oil lamps and oil stoves would do well to bear certain things in mind. The more nearly full the reservoir of the stove or lamp the less the likelihood of the oil getting hot enough to give off inflammable vapors in dangerous quantities. Glass or porcelain bowls are safer than metal, as they are poorer conductors of heat. When a lamp or stove reservoir needs refilling, the flame should first be extinguished, particularly if the reservoir is hot, in which case the space above the oil may be filled with vapors which would ignite easily when driven out by oil flowing in.

Fire Extinguishers.

Thus far we have talked about the production of fire. There come times when we should know how to extinguish fire. The common method is by use of water, which acts chiefly by reducing the temperature of the combustible below its ignition or kindling point, and also by producing steam, which is not a supporter of combustion. In case of oil fires there is danger of the water "spreading the fire" rather than quenching it. Often, too, more damage results from water than from fire, and other methods of

extinction are desirable. Rugs, blankets or other fabrics, particularly when made of wool, are often effective when thrown over the burning material, as they serve to shut off the air supply without which no ordinary fire can go on. Wet or dry earth and sand may often be used, and work in the same way as the blanket—shutting off the air supply. A common dry fire extinguisher consists of a mixture of dry sand and baking soda. The baking soda decomposes when it gets hot in the fire and liberates both water vapor and carbon dioxide gas, neither of which is a supporter of combustion. One type of fire extinguisher uses baking soda in solution, and sulphuric acid, the latter in a separate container so disposed in the apparatus that when the latter is turned bottom-side-up the acid and soda solution mix, producing carbon dioxide gas, which develops the pressure needed to eject the contents of the apparatus through the nozzle of a small hose against the burning material. The effective substances are the water and the carbon dioxide gas, with a little help from the sodium sulphate formed in the reaction within the cylinder.

Carbon tetrachloride is used in one of the popular commercial fire extinguishers. It is very effective, but there are frequent cases where its use results in the production of chlorine, carbon monoxide, hydrochloric acid and sometimes, phosgene, gases, all of which are dangerous to inhale in even small quantities. There is apt to be trouble of this kind when the fire is in an enclosed space, as in a house or garage.

Radiator Paints.

The paint used for decorating the surface of a radiator has a greater effect on its radiating efficiency than most persons might suspect. An elaborate series of experiments conducted in one of the Government laboratories at Washington has demonstrated the fact that those paints which have as their color base a finely divided metal (aluminum, bronze, and so-called "gold" paints) cut down the radiating efficiency of the heating unit more than two-thirds, though not materially cutting down the total heating effect. Heating units transmit heat in three ways—by *radiation* (in which case heat rays go out in all directions, sidewise as well as upward, and the body which stops these rays becomes warm); by *conduction* (in which case layers of moist air take up heat from the heating surface, pass it on to the next layer, and so on), and by *convection* (in which

case layers of air in contact with the heating surface get hot and rise, giving way to other layers which get hot in turn and rise). Ordinarily there is not much heat transmission in a room by conduction. Where there is radiation the air is more evenly heated, and generally only a short time elapses between the time the "heat is turned on" and its effects are noticed. Where there is mainly convection the heated air goes up and, being lighter than colder air, stays up, so that the whole upper strata of air in a room may be excessively hot while the lower strata may be very cold. Obviously, anything that increases radiation in a heating unit is a benefit. Dull black gives the best results, glossy black the next best, dull surfaces of other colors are better than glossy surfaces, and metallic-base paints seem to be the poorest. It is not necessary to remove the aluminum, bronze or gold paint from your radiator. Put the other paint on right over the metallic coat. The experience of a friend of mine may be of interest in this connection. He purchased a house in which the radiators were all painted with aluminum paint, and was told that the previous owner of the house had difficulty in keeping it warm. The new owner's wife did not care particularly for the metallic coloring of the radiators, so she painted them with other colors to harmonize with the other decorations of the respective rooms, using paints which gave dull surfaces. They have never had a particle of difficulty about getting plenty of heat out of the radiators.

When the heat goes up instead of out laterally, air currents are created at or near the floor level, felt as drafts on one's feet and ankles. These air currents gather up dust particles, carry them toward the radiator and, as the air gets hot and rises, the dust also goes up, some of it to lodge on the curtains or wall behind the radiator, some of it to stick to the ceiling above. The darkened places thus formed are responsible for the belief on the part of many housekeepers that steam and hot-water heating systems are dirtier than hot-air systems. As a matter of fact, they cannot bring dirt into a room, but they can and do afford the means by which it is gathered up and redeposited on more or less restricted areas. Unless the air is filtered, hot-air systems do bring dirt into a house, particularly in thickly populated sections and when the wind is blowing strongly, but it is rather evenly distributed through the house and over the furniture, and its accumulation is not so readily noticed.

Petromortis.

I cannot let the opportunity pass without sounding a strong note of warning as to the danger attendant upon the running of any kind of gas engine or gasoline motor in a confined space (such as a garage with all windows and doors closed) without first having made provision to carry the gases formed in the combustion of the "gas" out of doors. Frequently the "flivver" or "car" develops "motor trouble," and the owner or chauffeur starts it going and begins to tinker with the various parts in an effort to get it to "hit on all cylinders." The day is cold, so he has all doors and windows closed. The burning gas takes oxygen out of the air and pumps into it the same gases as are produced by the hall-bedroom oil stove or gas stove, except that the percentage of carbon monoxide is generally much higher in the exhaust of the engine. Perhaps some member of his family misses him and goes out to the garage to see "why he is so quiet," only to find him unconscious on the floor or in the car. If he is found soon enough he may be revived, but the "deadly monoxide gas" (see newspaper headings) has likely gotten in its work, and complete recovery, if it comes at all, may be only after a long time. If he is not found promptly, the coroner "sits on him" as a victim of what the doctors call petromortis, and somebody else "sits at the steering wheel" of his "machine" in the procession following the hearse which carries him on his last automobile journey on earth. Only a few weeks ago a prominent young lady in a Philadelphia suburb lost her life in just this kind of an accident. The rest of the family were away from home at the time. MORAL: Either leave a window or door open, or attach a hose or pipe to the exhaust of the engine and carry the other end to the out-of-doors; or, better yet, put on your overcoat and run the "bus" out into the yard or street. Better shiver for a short time than be "laid out cold" for all eternity by the "mortician," sometimes called "funeral director," more generally, "undertaker."

SOMETHING ABOUT GASES.

By Frank X. Moerk.

Of the three states of aggregation in which matter presents itself to us, namely, solids, liquids and gases, the last are characterized by an exceeding mobility so that definite volumes cannot be spoken of unless the gases be confined; they are exceedingly sensitive to changes in temperature and pressure, a decrease in temperature or an increase in pressure causing a decrease in volume, and an increase in temperature or a decrease in pressure causing an increase in volume. These effects are noted uniformly with all gases and only as they approach the stage of liquefaction are some irregularities noticed.

Vapors differ from gases in that they can, by a decrease of temperature, be reconverted into liquids or solids from which they were originally obtained.

Air is undoubtedly the most important gas because necessary for respiration and combustion; the proper explanation for these phenomena, however, was not forthcoming until 1777, not one hundred and fifty years ago.

A brief presentation of the development of our knowledge of gases should be of interest: In the sixth century B. C., Anaximenes and Heraklit considered air to be the elementary substance from which all other substances could be obtained.

Empedokles, about 440 B. C. viewed air, water, earth and fire as the fundamental materials; Agricola did not believe these to be fundamental substances but represented different properties of one fundamental substance. Wind, in some very ancient writings, is given instead of air.

As chemistry slowly developed during succeeding centuries, gases were evolved in chemical experiments, which are now known as hydrogen, carbon dioxide, etc., but which were then considered to be modifications of air; inflammable gases, as hydrogen and methane and gases not supporting combustion, as carbon dioxide, were confused with each other.

Philippus Aureolus Paracelsus (1493-1543), produced an inflammable gas by action of acids upon iron.

Galileo Galilei (1564-1642), generally called Galileo, the noted physicist and astronomer in 1597 constructed the first thermometer based upon the expansion of air.

Jan Baptista von Helmont (1577-1644), was the first one to use the term gas and to distinguish between gases and vapors. He made a study of carbon dioxide (gas sylvestre), and recognized this gas found in the stomach, in mineral water, in caves, as also being produced in the alcoholic fermentation, by the burning of carbon and by the action of acids upon limestone and potashes; but confused it with other gases which did not support combustion. He considered hydrogen and methane as being peculiar forms of gases. The difficulty in collecting gases accounts for many of his incomplete observations and it will be noted that the gases mentioned are not very soluble in aqueous solutions.

Evangelista Torricelli (1608-1647), produced the Torricellian vacuum in 1643 and found that the atmospheric pressure sustained a volume of mercury about thirty inches in height, equal to nearly fifteen pounds per square inch.

Otto von Guericke (1602-1686), discovered the air pump about 1650 and with the Magdeburg hemispheres carried out some startling experiments.

Robert Boyle (1626-1691), improved the air pump in 1659 and, by exhausting the air surrounding a barometer, proved that the height of the mercury column was due to atmospheric pressure. In 1660 he discovered the law that the volume of a gas was inversely as the pressure.

Edme Mariotte (1620-1684), in 1676 discovered the same law regarding the effect of pressure upon volumes of gases.

John Mayow (1645-1679), in 1669 stated that the air contains a substance which combines with heated metals forming calces (metallic oxides), which sustains respiration, which changes venous into arterial blood; the same substance is stated as being present in saltpeter. He devised methods for the collection and examination of gases.

Stephen Hales (1677-1761), made many improvements in the apparatus for generating and collecting gases, separating the evolution and receiving vessels. The apparatus was used by Black, Priestley and others and developed into the apparatus in use at the present time.

Gabriel Daniel Fahrenheit (1686-1736), about 1714 introduced the use of mercury for thermometers and from his experiments thought he had obtained absolute zero when the thermometer was immersed in a mixture of ice and salt; the volume of mercury em-

ployed expanded from 11,124 parts immersed in ice and salt to 11,156 parts at the melting point of ice and to 11,336 parts at the temperature of boiling water, giving the three important divisions on his scale, 0, 32 and 212.

Renè Antoine Ferchault de Reamur (1683-1757), about 1731 proposed his thermometric scale: melting point of ice = 0 and boiling point of water = 80.

Anders Celsius (1701-1744), about 1742 introduced the scientific thermometric scale known as the Celsius or centrigrade scale: melting point of ice = 0 and boiling point of water = 100.

Joseph Black (1728-1799), discovered latent heat in 1762; and determined that of water to be 140 degrees F. and that of steam to be 810 degrees F.; he also discovered specific heat; in heating limestone and magnesium carbonate he noted that a loss in weight was sustained due to the escape of a gas having the same properties as the "gas sylvestre" of Helmont and which, as it combined with the alkalies and lime, he called "fixed air"; he prepared caustic alkalies by treatment of mild alkalies (carbonates), with lime or magnesia. In 1767 he publicly demonstrated that a suitable vessel filled with hydrogen would ascend in the air as cork does in water.

James Watt (1736-1819), a friend of Black, in redetermining the latent heat of steam noted 950 degrees F. and utilized this in his work on the steam engine about 1765.

Henry Cavendish (1731-1810), in 1766 announced hydrogen, which he called "inflammable air," as a peculiar gas differing from other gases; in 1781 that water consisted of oxygen and hydrogen; in 1783 that air was a mixture of oxygen and nitrogen of constant composition, averaging 20.85 per cent. oxygen (at the present time 20.9 per cent. is accepted), determined by explosion with hydrogen; and that nitric acid could be produced from a mixture of oxygen and nitrogen by a spark discharge and also noted that a small residue of gas 1/120 of the amount of air started with, could not be made to combine with oxygen (first mention of inert gases other than nitrogen, in the air).

Joseph Priestley (1733-1804), prepared and examined many gases of which little was known; invented the pneumatic trough (1770), and the mercury seal for collecting gases; as a result he discovered gases which are soluble in water, as ammonia, hydrogen chloride, sulphur dioxide and silicon fluoride (the latter had undoubtedly been prepared before but collected over water decomposed

and gave rise to hydrofluosilicic acid). His greatest discovery, 1774, was the isolation of oxygen, "dephlogisticated air," by heating mercuric oxide and while aware of its stimulating influence upon burning bodies and also upon respiration he failed to properly interpret combustion processes although shrewd enough to note the part that oxygen played in animal and vegetable life. He found that oxygen combined with nitrogen dioxide and that the oxygen content of air varied between 18 and 25 per cent.; and that one-fifth of the volume of air was convertible into carbon dioxide, the remaining gas (nitrogen), was called "phlogisticated air."

Karl Wilhelm Scheele (1742-1787), in 1774 independently of Priestley, discovered oxygen, "fire-air," by heating mercuric oxide, black oxide of manganese, also other oxides and saltpeter. He also noticed that it increased combustion and respiration, and that the burning of a light in a confined volume of air produced as much carbon dioxide as oxygen disappeared. Scheele used ferrous hydroxide, moist ferrous sulphide and phosphorus for absorbing oxygen and arrived at the same volume percentage as Priestley. He was the first one to clearly point out that air contained a second constituent incapable of supporting respiration and combustion. He discovered chlorine in 1774 and hydrogen sulphide in 1777.

Daniel Rutherford (1749-1819), isolated nitrogen in 1772 by absorbing the carbon dioxide produced by respiration or combustion and announced the residual gas, which did not support respiration or combustion, as an atmospheric constituent.

Anton Laurent Lavoisier (1743-1794), had the master mind to correctly interpret the processes of respiration and combustion in 1777 and thus settle the controversy which engaged chemists during a century. Later he divided the known chemicals into elemental and compound substances and gave names to the elements indicating some chemical or physical property, names which have never been changed.

Humphrey Davy (1778-1829), was engaged in 1795 in a heroic task, namely, to test, by inhalations the action of gases as remedial agents; among those tried were nitrogen monoxide (afterwards used by dentists for anæsthesia and more recently in major operations), nitrogen monoxide and alcohol, higher oxides of nitrogen, methane and carbon dioxide; in 1815 invented the safety lamp, a device to prevent the explosion of mixtures of inflammable gases and air. He

suggested the use of liquefied gases as means of generating power and for the preservation of food.

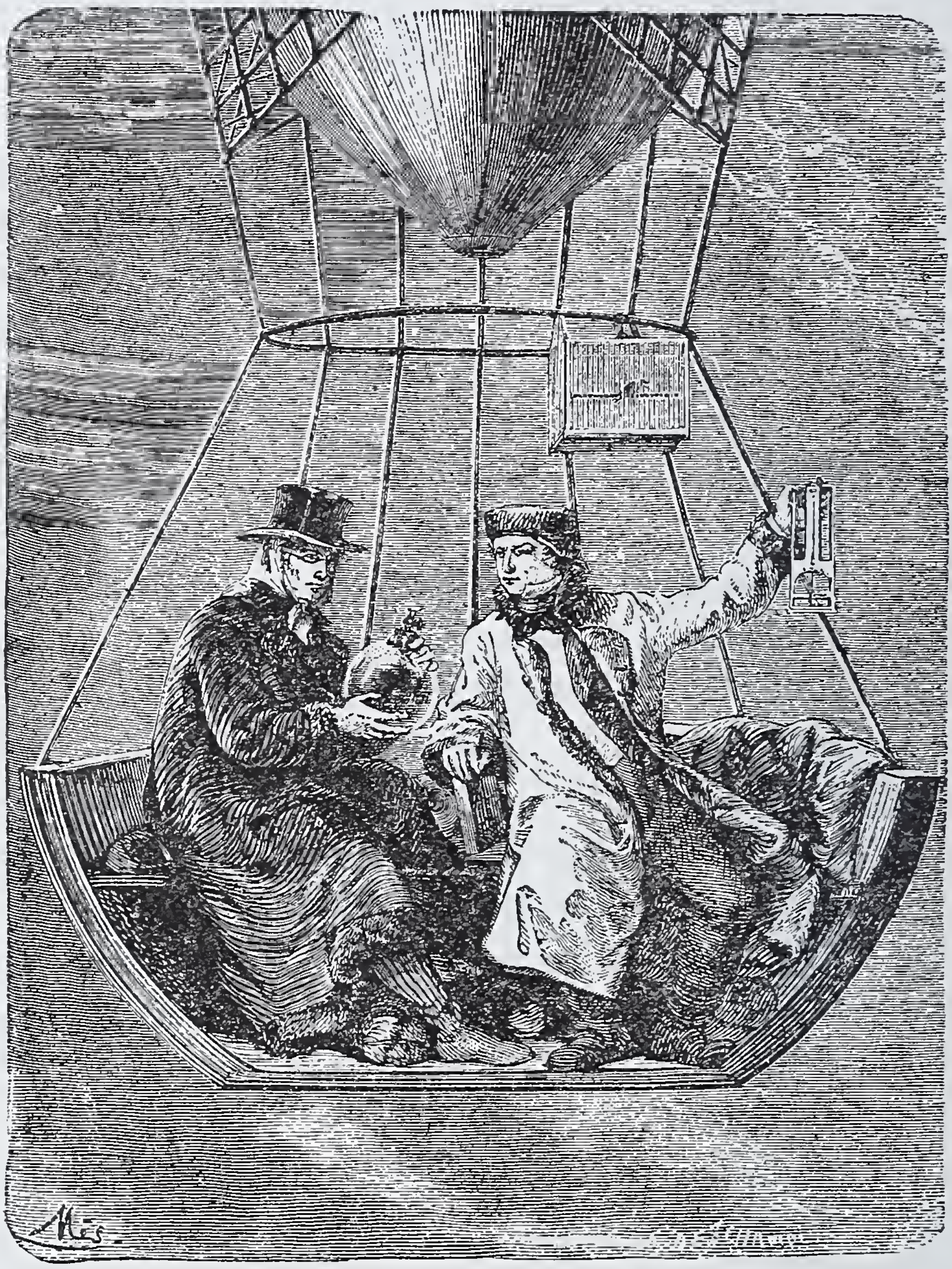
John Dalton (1766-1844), was early interested in the physical properties of gases, notably the expansion by heat and their absorption in liquids. His investigations on the chemical composition of gases led to the law of multiple proportions in 1802; thus he found that if, instead of expressing results as usual in terms of percentage, a special weight be adopted as a unit the analysis of ethylene would show twice as much carbon as methane, and carbon dioxide twice as much oxygen as carbon monoxide, etc. Dalton observed that the composition of the atmosphere was independent of the altitude and that the constancy was not due to simply mechanical agitation but due to diffusion as he proved by experiments that heavy gases diffused upward into lighter ones, while the latter diffused downward even though very narrow tubes. He faithfully kept a daily record of the weather and allied phenomena from 1787 to the very day of his death, a record embodying no less than 200,000 separate observations.

Joseph Louis Gay-Lussac (1778-1850), established laws relating to the volume combination of gases and discovered the relationship of volumes of gases as dependent upon temperature (1802), confirming the observations made by J. A. C. Charles about 1787. Gases at 0 degrees C. were found to expand 1/273 of their volume for an increase of 1 degree C. and to contract 1/273 for a decrease of 1 degree C.; from this law was calculated that absolute zero on the centigrade scale would be recorded as —273 degrees C. The Boyle-Mariotte law in connection with the Gay-Lussac and Charles law enabled reliable measurement of volumes of gases and calculation to standard conditions, namely, 0 degrees C., and atmospheric pressure at sea-level or 760 mm.

Gay-Lussac and Jean Baptista Biot (1774-1862), on August 24, 1804, ascended in a balloon equipped for making observations; as some doubt was expressed as to the accuracy of the observations, Gay-Lussac, on September 16, 1804, made another ascension, reaching an altitude of 23,000 feet, the highest attained up to that time; the barometer fell to 12.6 inches and the temperature from 31 degrees F. to —9.5 degrees F. These results confirmed those previously obtained. A bottle of air collected at this height, upon analysis, gave the same oxygen and nitrogen content as air collected at the surface of the earth.

Liquefaction of Gases.

Michael Faraday (1794-1867), devoted part of his energy to the liquefaction of gases; the experiments were carried out by generating and heating the gases in sealed, bent glass tubes and in many cases liquefaction resulted through the pressure produced by the heat; in later experiments one limb of the glass tube was cooled by immersion in a freezing mixture while the other was heated and this



Gay-Lussac and Biot making their balloon ascension for scientific observations in 1804.

method resulted in liquefying gases which withstood the first method. Explosions were frequent and many accidents occurred even with the safeguard of a glass-mask. The first gas liquefied was chlorine but Faraday gave credit to Thomas Northmore, who had liquefied it about 1805 by use of a pressure pump and gauge; other gases liquefied included sulphur dioxide, hydrogen sulphide, carbon dioxide, nitrogen monoxide, cyanogen, hydrogen chloride and ammonia; in

connection with the last he found that 100 grains of silver chloride absorbed 130 cubic inches of ammonia and when this compound was heated in a sealed tube the ammonia was again liberated and liquefied without trouble. All of this work was accomplished in 1823.

M. Bussy, in 1824 first used liquefied sulphur dioxide under reduced pressure, thereby hastening the evaporation of the sulphur dioxide, to produce lower temperatures than that of the liquefied gas and succeeded by this method in liquefying chlorine, ammonia and cyanogen.

M. Thilorier, in 1834, prepared liquefied and solidified carbon dioxide on a large scale and noted that a mixture of liquefied carbon dioxide and ether under reduced pressure enabled —110 degrees C. to be attained.

Faraday, in 1845, resumed his work on the liquefaction of gases and by employing two pumps and Thilorier's freezing mixture, solid carbon dioxide and ether, succeeded in easily liquefying and, in most cases, solidifying the gases experimented with in 1823 but failed in liquefying hydrogen and oxygen at 27 atmospheres, nitrogen and nitrogen dioxide at 50 atmospheres, carbon monoxide at 40 atmospheres and coal gas at 32 atmospheres. The freezing mixture of solid carbon dioxide and ether gave a temperature directly of —76.7 degrees C. and by placing the mixture under an air pump and exhausting to 1/26 atmosphere the temperature was reduced to —110 degrees C.; this low temperature could be maintained only for fifteen minutes; the gases solidified were: sulphur dioxide, hydrogen sulphide, nitrogen monoxide, hydrogen bromide, hydrogen iodide and ammonia. Faraday proclaimed liquefied nitrogen monoxide as the refrigerant of the future and J. Natterer in the same year, 1845, produced it on a large scale.

The low temperatures produced by the rapid evaporation of liquefied gases were not satisfactorily recorded by mercury and alcohol thermometers in use for registering natural temperatures, so thermometers containing carbon disulphide, phosphorus trichloride, air and hydrogen were used; later electrical resistance was utilized: in the thermo-electrical thermometer a resistance of 0.0001 volt indicated 1 degree C. and in the platinum-resistance thermometers a sensitiveness of 0.001 degree C. was reached.

During Faraday's time a large number of scientists became interested in the liquefaction of gases and by applying the methods of producing low temperatures just stated and subjecting the cooled

gases to immense pressure the number of gases which resisted liquefaction was gradually reduced and the following, which resisted all attempts, were called permanent gases: hydrogen, oxygen, nitrogen (air), carbon monoxide, nitrogen dioxide and methane.

Johann Wolfgang Döbereiner (1780-1849), of philosopher's lamp fame, in 1825 accidentally discovered the very rapid diffusion of hydrogen by noting that a cracked jar filled with hydrogen and standing in a pneumatic trough showed an increasingly higher water level inside the jar and explained this with the statement that the hydrogen passed out faster through the crack than the air could enter.

Thomas Graham (1805-1869), began in 1829 the study of the diffusion of gases which culminated in the discovery of the law that the rate of diffusion of gases is inversely proportional to the square root of the density.

Thomas Andrews, about 1862, discovered what is known as the critical temperature and critical pressure. Gases at a temperature above the critical temperature cannot be liquefied no matter how great the pressure: this explains the failures of J. Natterer in liquefying the permanent gases at the enormous pressure of 3000 to 4000 atmospheres (pressures exceeding that of exploding powder in cannons). The critical pressure is the pressure needed to liquefy a gas at its critical temperature. This work of Andrews led to renewed efforts in liquefying the permanent gases.

Louis Paul Cailletet and Raoul Pictet in December, 1877, within a few days of each other, succeeded in liquefying oxygen. The gas subjected to intense cold and pressure (320 atmospheres), failed to liquefy but upon releasing the pressure greater cold was produced by the expansion of the gas and some of the oxygen was liquefied. Pictet cooled the gas by liquid sulphur dioxide to —25 degrees C. and then by liquid carbon dioxide to —140 degrees C.; Cailletet used liquid carbon dioxide, nitrogen monoxide and ethylene and attained —136 degrees C., lowered by releasing the pressure to —200 degrees C. Pictet also liquefied hydrogen (1878), and Cailletet acetylene, nitrogen dioxide, carbon monoxide, nitrogen, hydrogen and methane (1881); the last was suggested as the refrigerant of the future.

Sigmund Wroblewski and Karl Olszewski in 1883 liquefied oxygen, nitrogen and carbon monoxide and, later, air and hydrogen, using for the last boiling oxygen as the refrigerant, for the others liquid

carbon dioxide and ethylene. Oxygen liquefied at —130 degrees C., and 20 atmospheres, nitrogen and carbon monoxide at —136 degrees C., and 150 atmospheres; oxygen was liquefied in sufficient quantity to transfer it from one vessel to another. All the permanent gases were liquefied and nitrogen, nitrogen dioxide, carbon monoxide and methane solidified. Wroblewski predicted in 1884 that liquid air would be the refrigerant of the future.

James Dewar, by using liquid nitrogen monoxide, cooled liquid ethylene to —90 degrees C., and by forcing the evaporation of the latter attained —145 degrees C., to which temperature oxygen, under a pressure of 50 atmospheres, was cooled causing its liquefaction; in draining off the liquid oxygen at this pressure about 90 per cent. was lost. Air and other gases were liquefied in a similar manner. Later air and oxygen under 150 atmospheres pressure were cooled by liquid carbon dioxide to —79 degrees C., and after fifteen minutes drops of the liquefied gases could be collected and as much as 100 cc. obtained in one operation; in this process the compressed gas by release of pressure furnished some of the cold to cause its own liquefaction.

To prevent the rapid evaporation of liquefied gases, Dewar constructed special flasks consisting of double or treble walled glass vessels, forming two or three bulbs, with a Torricellian vacuum between the bulbs; by an ingenious treatment with liquid air the mercury vapor filling this vacuum was condensed and either partly or entirely removed before sealing the outer bulbs. The inner bulb in which the liquefied gases are stored is therefore protected by the most complete vacuum known. The calculated pressure of mercury vapor at 0 degrees C. is expressed as 0.000126 millimeters pressure or one six-millionth of an atmosphere (an atmosphere equals 760 millimeters); experiments show that a Torricellian vacuum of twenty liters capacity contains two milligrams mercury and if the mercury vapor in this vacuum be condensed by liquid air the pressure of the remaining mercury is reduced to 0.00000003 millimeters or two and a half millionths of a millionth of an atmosphere.

The Dewar flasks can be further improved by silver coating the outside of the bulb in which the liquefied gas is stored; this metallic surface will reflect radiant heat which alone can pass through the vacuum. Instead of the silver coating a very small amount of mercury can be left in the space between the inner and its surrounding bulb which at ordinary temperature will form a vapor and be invisible

but when liquefied gases are placed in the inner bulb the mercury will condense and form a metallic coating on the outside surface of the inner bulb.

When liquefied gases are placed in these flasks some of the liquid passes into the gaseous condition with further decrease of temperature and the space above the liquid is filled with the intensely cold gas which prevents contact with the warmer air; between the liquid and the walls of the container there forms a thin film of gas preventing actual contact between the liquid and the container, in other words acting as a cushion. This is the so-called "spheroidal state" and allows the handling of these intensely cold liquids without danger; if the liquid were to come in direct contact with the skin severe burns would result.

Dewar and Moissan in 1897 liquefied fluorine, by use of liquefied oxygen, at a temperature of —187 degrees C., but did not succeed in solidifying it at —210 degrees C.

In 1898 Dewar obtained liquefied hydrogen in quantity by cooling the gas to —205 degrees C., under a pressure of 180 atmospheres and allowing the compressed gas to escape from the nozzle of a coil of pipe at the rate of 10-15 cubic feet per minute into a vacuum vessel kept at —200 degrees C.; drops of liquefied hydrogen soon appeared and 20 cubic centimeters collected in five minutes when the jet closed due to frozen impurities. One per cent. of the gas had been collected as liquid.

Liquefied air is turbid due to particles of solidified carbon dioxide, which gas is present in small quantity in the air; liquefied oxygen is turbid if the oxygen be made from potassium chlorate due to the presence of a little chlorine.

Liquefied air and oxygen can be solidified by cooling with a jet of liquid hydrogen. Dewar found helium to be the extent of 0.12 volume in 100 volumes of gas obtained from the water of King's Well in Bath, England; from 70 liters of this gas he obtained about 20 cc. which could not be liquefied and which consisted of practically equal volumes of nitrogen and helium; the liquefied gas was nitrogen. Helium was liquefied by the cold of liquid hydrogen, but could not be liquefied by the use of liquid air.

If a tube containing air be sealed and one end immersed in liquefied hydrogen for one minute, the air will solidify and separate in the lower part of the tube; if the glass of the tube be then softened by means of a blow-pipe, above the liquid hydrogen the atmospheric

pressure will seal the tube and produce a vacuum tube without the aid of a pump or apparatus of similar function. A more easily solidified gas could be used for filling the tube and liquid air used instead of liquid hydrogen. Sir William Crookes, an authority on high vacua, found a higher vacuum in these tubes than in tubes made by exhausting for several hours with a mercury pump.

Liquefaction of Air on a Commercial Scale.

The work so far recorded in the liquefaction of what had been called "permanent gases" was accomplished by disregarding expense of installation, the latter including the costly liquefied gases which by rapid evaporation produced low temperatures to cool the gas to be liquefied and this cooled gas then by release of pressure produced a still lower temperature with liquefaction of part of the gas. In some of Dewar's work 10-15 cubic feet of hydrogen cooled under pressure were allowed to escape per minute producing one per cent. of liquefied hydrogen; some idea of this lavish use of hydrogen can be obtained by recalling that an ordinary gas burner delivers five cubic feet of gas per hour.

A number of experimenters took up the problem of producing liquefied air on a large scale; prominent in this field were Trippler, Linde and Hampson, who independently of each other succeeded in solving the problem by using compressors either with or without water as the cooling agent.

The air is subjected to a pressure of 80 to 170 atmospheres and the gas which becomes heated during the compression is cooled by water; it next passes into a liquefier, a long cylindrical container, carefully insulated, containing a long coil of pipe closed at the bottom by a valve and a receptacle for the storing of the liquefied gas with a valve for the withdrawal of the liquefied gas. The cooled compressed gas is allowed to escape through the valve into the space outside the coil; this release of pressure allows the compressed gas to expand and in doing this it is further cooled; after escaping from the coil it must travel upward and therefore it cools the descending gas in the coil, and when this escapes from the valve it will be at a still lower temperature. This additional cooling of the compressed air continues until the temperature is so lowered that under the pressure employed some of the air is liquefied and collects in the provided receptacle, from which it can be removed without much loss as it is not stored under great pressure.

In some modifications of the described process there may be two or three coils of pipe inside each other and made of thin metal so that changes of temperature will be rapidly conveyed from one coil to the other. Using two coils the compressed gas passes down the inner coil and the expanded cooler gas passes upward through the outer coil. Using three coils the compressed gas passes down the inner coil and after expansion a portion, which can be regulated, passes up the middle coil to cool the descending gas, the balance passes up the outer coil and acts as an insulation. A vacuum pump may be part of the apparatus to more rapidly expand the gas as it leaves the inner coil.

Trippler produced from 3-4 gallons liquid air per hour and has sent it in milk cans, insulated by a covering of felt, to distant points.

Linde prepared per hour about 3 quarts liquid air containing about 70 per cent. oxygen.

Hampson produced 1.2 quarts of liquid air per hour; in making liquid oxygen from compressed oxygen gas, the apparatus is first cooled with liquefied carbon dioxide.

Liquid air in a test tube, under reduced pressure, boils and the tube becomes coated with snow from the moisture in the atmosphere; later, liquefied air drops from the bottom of the tube, showing that the temperature produced by the rapid boiling of liquefied air is capable of liquefying air.

Trippler has used liquefied air to crystallize and purify chloroform and alcohol; the latter solidifies at —130 degrees C.

Liquid air boils at —192 degrees C. and as nitrogen boils at —195.7 degrees C. and oxygen at —182 degrees C. the nitrogen will escape first with a little oxygen, leaving oxygen either pure or mixed with some nitrogen, depending upon conditions.

Rarer Constituents of the Atmosphere.

Cavendish noted that in sparking a mixture of air and oxygen a residual gas was always obtained amounting to about 1/120 of the volume of air taken.

Rayleigh in 1893 found a discrepancy in the weight of a liter of nitrogen obtained from the air and nitrogen obtained from some of its chemical compounds, the former weighing 1.25718 gms., the latter 1.2507 gms.; or expressed in terms of specific gravity, the former 0.97209, the latter 0.96737.

While nitrogen as an element was considered to be inert, it could be made to combine with oxygen with the aid of the electric spark, also with magnesium at higher temperatures, producing magnesium nitride; by these methods Rayleigh and Ramsay obtained from atmospheric nitrogen a more inert gas and called it "argon."

In 1895 Ramsay made an investigation of the gas obtained by heating the mineral, cleveite, which, owing to its inertness had been considered to be nitrogen; the nitrogen was removed by heating with magnesium and the residual gas which did not combine with magnesium was found to be helium, an element discovered in 1868 in the sun's atmosphere. Later helium was found in other minerals, in gases obtained from some mineral springs and, more recently, in larger quantity in natural gas from wells in the southern and southwestern states.

The discovery of these two gases and their placement in the periodic system suggested that there must exist other gases belonging to the same group; by the evaporation of large quantities of liquid air three other gases, helium, neon and xenon were discovered and by the evaporation of crude argon, a fifth gas, krypton, was discovered. In the detection of these gases the examination of the spark spectra was of great value; the vacuum tubes of Dewar made by use of liquid hydrogen, gave the spark spectra of hydrogen, neon, helium and carbon (the last attributed to carbonates in the glass).

These rare gases make up less than one per cent. by volume of the atmosphere, and the individual quantities may be stated as follows:

One	volume	argon	is	present	in	107	volumes	of	air.
"	"	neon	"	"	"	81,000	"	"	"
"	"	helium	"	"	"	250,000	"	"	"
"	"	krypton	"	"	"	20,000,000	"	"	"
"	"	xenon	"	"	"	40,000,000	"	"	"

They form a group of inert gases and have resisted all efforts made to combine them with other elements.

In 1903 Ramsay and Soddy, in a study of the radium emanations, discovered a gas which was named "niton" and found that it belonged to the group of inert gases; niton, kept in glass tubes for a few days, disappeared and helium appeared in its place constituting the first record of the transmutation of an element.

	Critical Temperature °C	Critical Pressure Atmospheres	Boiling Point °C	Solidifying Point °C	Other Conditions for Liquefaction
Argon	—122.4	47.9	—186.9		
Helium	—267.8	2.75	—269		
Krypton	— 62.5	54.3	—151		
Neon	—213	29	—248	Liquid Hydrogen	
Niton	+104.5	62.5	— 62		
Xenon	+ 16.6	58.2	—109		
Acetylene	+ 36.5	61.6	— 85	— 81	15 C°, 83 Atm.
Air	—140	39	—192	Liquid Hydrogen	
Ammonia	+130	115	— 33.5	— 77	—40° C;+10° C, 6-7 Atm.
Carbon Dioxide	+ 31.1	73	— 78.2	— 56	0° C, 35 Atm.
Carbon Monoxide	—141.1	35.9	—190	—211	
Chlorine	+146	93.5	— 33.6		—34° C;+12.5° C, 8.5 Atm.
Ethylene	+ 10	51.7	—102	—169	
Hydrogen	—243	19.4	—252.8		
Hydrogen Chloride	+ 52.3	86		—116	+10° C, 40 Atm.
Hydrogen Oxide (Water)	+365	196.4	+100	0	
Hydrogen Sulphide	+100	88.7	— 62	— 83	17 Atm.
Methane	— 95.5	50	—164	—186	
Nitrogen	—146	35	—195.7	—211	
Nitrogen Dioxide	— 93.5	71.2	—154	—167	
Nitrogen Monoxide	+ 38.8	77.5	— 89.8	—102	—88° C; 0° C, 30 Atm.
Oxygen	—113	50.7	—182.9	—252	
Ozone			—106		
Sulphur Dioxide	+155.4	78.9	— 10	— 76	—18° C;—10° C, 3 Atm.

Composition and Uses of Air.

Collected from various parts of the globe, high or low altitudes, air has practically a constant composition; of course there will be variations if the samples be taken from places where large quantities of oxygen are consumed for respiration and other forms of combustion, as the use of fuel for heat and power, the manufacture of sulphuric acid from sulphur or metallic sulphides, the extraction of gold and silver by the cupellation process, etc., or in places where other gases may be produced in quantity and allowed to escape into the air, as near lime kilns, blast furnaces, etc.

The vastness of the air supply is shown by a calculation published some years ago which was based upon a daily consumption of 20 cu. ft. of oxygen by a grown person while the oxygen for animals and for all other oxidation purposes was taken as nine times the amount allowed for mankind; at this rate it would require 1300

years to show a decrease of 0.1 volume per cent. in the oxygen content of the air.

The constancy of the composition of the air is maintained by cycles of changes involving both the animal and vegetable kingdoms. Animals require oxygen to free the blood from impurities, thereby changing venous into arterial blood; the gaseous product, carbon dioxide, is exhaled while liquid and solid products of oxidation are eliminated through the skin, kidneys and alimentary canal. Plants take up the carbon dioxide and exhale oxygen. Nitrogen is also required by plants, but atmospheric nitrogen must first be made assimilable and this is accomplished by electric discharge or by certain bacteria; some of the plants may go as food to the animal kingdom and both plants and animals after death and decay will again yield nitrogen going into the air or other nitrogenous products going into the soil.

The analysis of dry air free from carbon dioxide shows the following percentages:

By Volume:	Nitrogen	78.06,	Oxygen	21.00,	Argon	0.94.
By Weight:	"	75.50,	"	23.20,	"	1.30.

Helium, Hydrogen, Krypton, Neon and Xenon in Traces Only.

The *carbon dioxide* content of air is about 4 parts in 10,000 parts (by volume). Air is necessary for respiration and combustion; a person exhales about 0.6 cu. ft. of carbon dioxide per hour and as the content of this gas in living rooms should be kept below 7 parts in 10,000 parts, it is necessary to supply each person with 1800 cu. ft. of fresh air per hour; in using fuels for heat or power the following quantities of air are necessary: coal, per pound, 200 cu. ft.; oil, per gallon (fuel, kerosene or gasoline), 1866 cu. ft.; natural gas, per cu. ft., 9-10 cu. ft.; manufactured gas, per cu. ft., 4-5 cu. ft. A large ocean steamer is stated to pour out of her funnels about a ton of carbon dioxide per minute.

If the products of combustion are not passed into a flue or chimney, good ventilation must be provided, otherwise quantities of carbon dioxide dangerous to life will accumulate. With an insufficent supply of air, the carbon of the fuel will be imperfectly oxidized producing the much more poisonous carbon monoxide. Deaths have frequently resulted from furnace gases because of an insufficient air supply; since the introduction of the automobile, and the storage of the same in the usually small garage with its limited

air supply, quite a number of deaths have been recorded due to attempted repairs in the closed garage while the engine was kept running. It may be well to here emphasize the fact that carbon, either as coal or coke or as present in fuel oils, will burn in excess of air to form carbon dioxide and then, as the oxygen diminishes, take away half the oxygen from the carbon dioxide, producing the deadly blood-poison, carbon monoxide; victims of this poisonous gas probably never realize their danger. These statements should emphasize the importance of ventilation.

Water vapor is the one air constituent which is most variable in amount, the quantity depending upon the temperature, but averaging a little less than 1 per cent. by volume. 1800 cu. ft. of air, perfectly saturated with water vapor (100 per cent. humidity), at 25 degrees C. (77 degrees F.), contain almost 2.5 pints of water; upon cooling to 0 degrees C. (32 degrees F.), the air will show 100 per cent. humidity, for this temperature, but will contain only about 0.6 pint of water, the difference between the 2.5 pints and 0.6 pint being precipitated as rain. Water vapor is lighter than air, therefore, the more water vapor present the lower the barometer reading and a falling barometer is one of the signs of approaching rain. A proper humidity is essential for the comfort of man (or beast); ordinarily air is saturated with water vapor to the extent of 50-70 per cent.; if the humidity is greater the air is damp and sultry; on the other hand, if less it is uncomfortably dry. During the summer months when the humidity is naturally higher, electric fans and artificial cooling will add comfort; during the winter months when the humidity is low and artificial heating is necessary for an agreeable indoor temperature the uncomfortable dryness can be remedied by the evaporation of sufficient water to increase the humidity and thereby prevent many of the throat and lung troubles so prevalent during this period.

It is customary during the winter to maintain, as near as possible, a temperature of 70 degrees F. (21.1 degrees C.), in living apartments, but with the proper humidity 68 degrees F. (20 degrees C.), is found comfortable. The 1800 cu. ft. of fresh air, stated before as necessary to keep the carbon dioxide within desirable limits, to register 100 per cent. humidity, must contain about 1.9 pints of water; the proper humidity at 20 degrees C. is 40 per cent. and this means that 0.76 pint of water will have to be evaporated every hour, or for a family of five people about 0.5 gallon of water.

Uses of air in which no change in composition is evolved.

(1) The propagation of sound waves upon which depends speech, music, telephone, phonograph, radio transmission and reception, alarm clocks and other forms of signals; (2) the use of compressed air in automobile tires, in pneumatic drilling tools, in air brakes, in sand-blasts for cleaning brick and stone buildings, for mechanical etching of glass, for enforced draught, for separating chaff from grain, for drying as in dental work, etc.; (3) the use of so-called vacuum cleaners, in which air currents pick up and carry dust and other light particles, like saw dust, into a receptacle from which the air can escape and in which the collected solids are deposited, in cupping and in the use of breast and stomach pumps (forms of suction pumps) atmospheric pressure forces liquids and solids into a receptacle in which a vacuum has been produced by heat or a pump; (4) the use of air as a condensing or cooling agent as seen in the immense metallic structures extending into the air and constituting an important part of ice and of liquefied gas plants, also seen on a less pretentious scale in the recovery of constituents of higher boiling point in the refining of petroleum, etc., and utilized for preventing excessive heating of motors and automobile engines.

Uses of air depending upon the oxygen content.

(1) Respiration, previously explained. (2) Fuel combustion for heat and power; in addition to statements already made, the terms, calorie (ca) and British thermal unit (B. t. u.) may be explained as they are so frequently used in expressing the value of fuels; the calorie represents a heat unit which will raise the temperature of one gram of water 1 degree C. and the calorific value of solid and liquid fuels is an expression of the number of grams of water which can be raised 1 degree C. by the burning of one gram of the fuel; the "British thermal unit," on the other hand, represents the number of pounds of water which can be raised 1 degree F. by the burning of one pound of fuel; calories can be converted into B. t. units by multiplying by 1.8 and B. t. units can be changed into calories by dividing by 1.8; in the case of gaseous fuels the value is expressed in calories per cubic foot, which may be converted into B. t. units by multiplying by 3.97, the reverse conversion by dividing by 3.97. Another method of expressing the value

of fuel gives the weight of water at the boiling point which can be converted into steam of the same temperature as 536 calories or 965 B. t. units (536 x 1.8), are required for this change in condition, the calorific value in calories divided by 536 will give kilograms of water at 100 degrees C., which can be changed into steam at 100 degrees C.; or the calorific value in B. t. units divided by 965 will give pounds of water at 212 degrees F., which can be converted into steam at 212 degrees F. If the water be below the boiling point less can be vaporized by the same weight of fuel; thus starting with water at 40 degrees C., the divisor would be 536 plus (100-40) or 596; or starting with water at 80 degrees F., the divisor would be 965 plus (212-80) or 1097. (3) Illumination: with the exception of the electric light bulb, all other forms of illuminants require oxygen, the value of the illuminant being expressed in terms of "candle-power" and has reference to a sperm candle burning 120 grains per hour. The illuminants in use at the present time are kerosene, gas and electricity; illuminating gas used as a source of heat and light varies considerably in composition depending upon its source:

	Coal Gas	Water Gas	Carburetted Water Gas
Illuminants	5%	0.0%	16.6%
Methane	34.5	1.0	19.8
Hydrogen	49.0	36.0	32.1
Carbon Monoxide	7.2	51.0	26.1
Nitrogen	3.2	7.0	2.4
Carbon Dioxide	1.1	4.0	2.4

Especial attention is called to the poisonous carbon monoxide content.

The greatest advance in the use of gas for illumination was due to the invention and perfection of the Welsbach mantle, in which a nonluminous but hot flame could become a luminous flame by heating certain metallic oxides (cerium and thorium), to incandescence; the candle power of a gas being raised to as high as 50, in comparison with 12-18 as given by the usual gas. (4) The drying of paints in which the linseed oil by taking up oxygen changes into the varnish-like film offering protection to wood and metal; of the metals, iron is the most important for structural, roofing and other uses but exposed to moist air it oxidized (rusts), becoming

pitted and perforated; to retard this weakening effect, iron is coated with tin (tin-plate), zinc (galvanized iron), and copper, but even this protection is not permanent and requires painting. Zinc and copper, therefore, are used to replace iron for some purposes and being only superficially changed by the oxygen and carbon dioxide in the air to basic carbonates, zinc turning white and copper green. (5) The manufacture of sulphuric acid: Sulphur and metallic sulphides on heating will combine with oxygen producing sulphur dioxide and this in the presence of oxides of nitrogen or catalytic agents will combine with more oxygen producing sulphur trioxide which with water or steam gives sulphuric acid. (6) In the extraction of gold and silver by the cupellation process an alloy of the precious metals with lead is obtained which by heating in air leaves the gold and silver while the lead forms a fusible lead oxide the last traces being absorbed in a bone-ash cupel. (7) The action of air depending upon oxygen as its active constituent, numerous methods have been proposed and used for extracting oxygen from the air; the method, superseding all others depends upon the property of liquefied air first giving off nitrogen leaving oxygen of various degrees of purity depending upon the yield. In using air in combustions the 80 per cent. inert nitrogen absorbs considerable heat; proper mixtures of oxygen with hydrogen or illuminating gas, more recently with acetylene gas are used for the generation of intense heat; one gram hydrogen burning in oxygen will develop 34,200 calories, one gram carbon in the same way 8080 calories; the temperature of the oxy-hydrogen flame is given from 2100 degrees to 2500 degrees C., that of the oxy-acetylene flame or torch as 2500 degrees C. (8) Ozone, a very active form of oxygen, produced to the extent of about 6 per cent. when the silent electric discharge is passed through air or oxygen; one part of ozone per million parts of air determines the difference between tolerable and intolerable conditions with a limited air supply; used in ventilation and water purification, in bleaching, deodorizing and oxidizing oils; important in cold storage of foods, suppressing the deleterious changes noted when the temperature rises above the critical point. (9) Atmospheric nitrogen can readily be prepared by a number of processes in which the oxygen is made to combine with other substances under proper conditions; thus by passing air over heated metallic copper; by burning carbon, sulphur or phosphorus in a confined volume of air; by agitating air with an alkaline suspension

of ferrous or manganous hydroxides or with an alkaline solution of pyrogallol; when other gases are produced as in the burning of carbon and sulphur, these can be removed by the addition of an alkali.

The fixation of atmospheric nitrogen rendering it available for fertilizer and other uses can be accomplished yielding several products: (a) Calcium nitrate, or nitric acid. Air, passed through a special furnace heated to 3500 degrees C. by arc flames produced from an alternating current of 5000 volts, leaves the furnace containing about 2 per cent. nitrogen dioxide which upon rapid cooling combines with more oxygen forming nitrogen tetroxide and absorbed in water will finally yield a 50 per cent. nitric acid; the gas not absorbed by water is passed over slaked lime yielding an additional quantity of calcium nitrate into which compound the nitric acid is also converted and prepared for the market as fused calcium nitrate. This can be used as fertilizer or used for the preparation of nitric acid. (b) Calcium cyanamide. Calcium carbide, a product of the electric furnace, if heated in such a furnace to 2000 degrees C. will absorb nitrogen from a current of air producing calcium cyanamide, also called "nitro-lime," useful as a direct fertilizer (20 per cent. nitrogen), or by fusion with alkalies yields cyanides. (c) Ammonia can be synthethized by passing a mixture of 3 volumes hydrogen and 1 volume nitrogen at 500 degrees C. and 150 atmospheres pressure over a catalyzer, an iron-uranium alloy; may also be made by action of superheated steam upon calcium cyanamide or magnesium nitride. (d) Nitric Acid. Ammonia gas with 10 volumes air rapidly passed over an electrically heated catalytic agent as platinum gauze or pure iron activated with metals like bismuth, copper, tungsten, etc., can be oxidized to nitric acid.

The methods used for the separation of the rarer atmospheric gases have been given in a previous section.

Next will be considered a few cases where air must be excluded: (1) Barometers. The space above the mercury (Torricellian vacuum), must be perfectly free from air to prevent inaccuracies in graduation. (2) Mercury thermometers. Made by boiling the mercury in the thermometer tube, sealing and graduating, their use is limited to the temperatures between the freezing and boiling point, —40 degrees C. and 350 degrees C.; but if the space above the mercury be filled with gases under pressure much higher temperatures can be recorded, the limit being the temperature at which the

glass softens. Thermometers made of Jena glass and the space above the mercury filled with nitrogen can be used for temperatures as high as 550 degrees C.

(3) Vacuum tubes. These are made for different purposes and in various designs; Geissler tubes, used to show the effect of rarefied gases upon electrical discharges of high tension, pressure in these is reduced to 0.76 mm. mercury. Crookes tubes to show cathode discharge or X-rays, pressure reduced to 0.000760 mm. mercury. Electric light bulbs. These contain a fine filament of tungsten which by the passing of the current becomes white-hot, in the presence of air (oxygen), the filament would oxidize and break the current; for some years these tubes represented the most perfect vacuum but are now surpassed by the radio tube; in more recent forms of electric light bulbs nitrogen and argon are used. Neon tubes are used to test the ignition in automobile engines, an orange glow showing an electric current and the brightness of the glow the relative quantity. Radio tubes used as detectors and amplifiers contain a filament made of platinum-iridium alloy coated with oxides of barium and strontium; the filament is heated by a low voltage (1-6) current; the exhaustion of the air by pumps is effected while the tube is heated, the pressure being reduced to 0.000001 mm. mercury; radio tubes are spoken of as hard and soft, the former containing the more perfect vacuum. To emphasize the figures given in connection with these vacuum tubes it may be well to recall that the atmospheric pressure is equal to 760 mm. mercury. Vacuum tubes are now used as essential parts in apparatus for examining the action of the heart and for recording various forms of deafness and correction of this affliction. (4) Thermos bottles represent a practical application of the Dewar flasks.

(5) In preserving and canning food products air is removed by boiling the material, filling the heated containers and sealing; in addition to removing air, boiling sterilizes the product, meaning thereby the destruction of bacteria which are present in the air and which may be on the material to be preserved; imperfect sterilization is indicated in the case of material stored in glass jars by gas bubbles below the surface of the material, in the case of canned goods by a bulging of the metal or by the escape of gas when the can is opened. It should be needless to say that such goods should not be eaten.

Refrigeration.

Very closely connected with the last subject is the preservation of food by reducing the temperature. Probably the most ancient method is found in the cooling of water, by placing it in an unglazed earthenware container and setting this in a shady place; the water penetrating the container is converted by air currents into water-vapor, a change requiring heat which is furnished by the water in the container with a lowering of temperature. The old-time spring house cooled by spring water and in which were kept milk, butter and other victuals. The use of ice, which in melting takes up heat from surrounding objects, is now the consumers' method of keeping foods in good condition; but manufacturers and large dealers have installed refrigerating plants controlled automatically so that the desired temperature is readily maintained. The principle employed in these installations depends upon the fact that gases by pressure and cooling are liquefied with evolution of heat, the latter removed by air or water cooling; upon releasing the pressure the liquid passes into the gaseous condition by abstracting heat from surrounding objects thereby producing cold; this cycle repeats itself, regulated by the automatic control. There are two methods of utilizing the lowering of the temperature, in the so-called direct method, the cold gas circulates through pipes in the container, room or building to be cooled; in the indirect method the cold gas circulates in pipes placed in a tank containing a brine, either sodium or calcium chloride, and this cooled brine then circulates through the space to be cooled. The liquefied gases used on a large scale are ammonia and carbon dioxide; the former used in buildings, the latter preferably on ships. Within the past few years small installations to be used in the household have appeared; the tank containing the brine being placed in the refrigerator, the condensing pump and motor in a convenient closet; liquefied sulphur dioxide is most generally used and forms are provided which filled with water and lowered in the brine will yield small cubes of ice.

Combustible and Non-Combustible Gases.

1. Combustible: Acetylene, carbon monoxide, ethylene, hydrogen, hydrogen sulphide, illuminating gas, methane.
2. Non-combustible: Ammonia, carbon dioxide, carbon oxychloride, chlorine, sulphur dioxide, nitrogen, and the rarer atmospheric gases.
3. Supporters of combustion: air, oxygen, nitrogen monoxide.

The combustible gases will burn in air or oxygen; if quantities of these gases be mixed with air or oxygen and a flame brought near the mixture or an electric spark produced near the mixture dangerous explosions and fires may follow. Where are such mixtures possible? Illuminatng gas and air: leaks in pipes or open stopcocks; we have all read of people looking for a gas leak with a lighted candle; acetylene and oxygen: in the use of the oxy-acetylene torch in an unventilated place if the gases are turned on before lighting the acetylene, or if the flame should be extinguished and allowed to flow some time before relighting; hydrogen and oxygen: the oxy-hydrogen blow-pipe under the same conditions as oxy-acetylene torch; the charging of storage batteries gives this mixture in its most effective proportions and looking into the storage batteries with the aid of a flame to see what is doing is on par with the hunter for the gas leak; carbon monoxide and air: putting coal on a fire without sufficient draught is often followed by the stove door being blown open, if the gas has escaped into the cellar do not look for it with a flame; this mixture may also be produced by running the automobile engine in a closed garage and then allowing air to enter; methane and air: the dreaded "fire damp" of the coal miner set off by a light or spark. Davy's safety lamp does not prevent small explosions taking place within the metallic gauze enclosing the lamp proper, but will prevent the flame from coming in contact with the dangerous mixture outside of the gauze.

There may be explosions due to other causes: many of the liquefied gases are stored under heavy pressure; should the container give way, the sudden liberation of a large volume of gas may be dangerous; the gradual formation of gases in a confined space may result finally in an explosion, this may happen in saccharine liquids containing an insufficient amount of sugar to prevent fermentation due to the formation of carbon dioxide, as in the fermentation of one ounce of cane-sugar about 17 pints of carbon dioxide will be produced; boiler explosions due to water coming in contact with red-hot tubes, 1 cu. inch water producing 1696 cu. inches of steam.

Fire Extinguishers.

These generally depend upon the liberation of considerable volumes of non-combustible gases, preferably heavier than air so as to envelope the substance on fire and prevent access of air. Among the chemicals used are sodium bicarbonate mixed, when

needed, with sufficient sulphuric acid so that the liberated carbon dioxide will force the mixture out of the container. Sodium thiosulphate liberates sulphur dioxide; ammonium sulphate liberates nitrogen and sulphur dioxide. Carbon tetrachloride, a non-inflammable liquid, is much in use forming a very heavy vapor but which when hot produces with water a poisonous gas, carbon oxy-chloride.

Poisonous Gases.

This group includes: Illuminating gas, carbon monoxide, carbon dioxide, nitrogen, ammonia, chlorine and sulphur dioxide; the last two are used for bleaching, the former for cotton, the latter for wool.

Medicinal Gases.

Oxygen is used to keep up respiration during critical stages; ozone as a sterilizing agent and for purifying air and water.

Nitrogen monoxide, alone or mixed with oxygen, liquified air and ethylene are used as anæsthetics.

Carbon Dioxide.

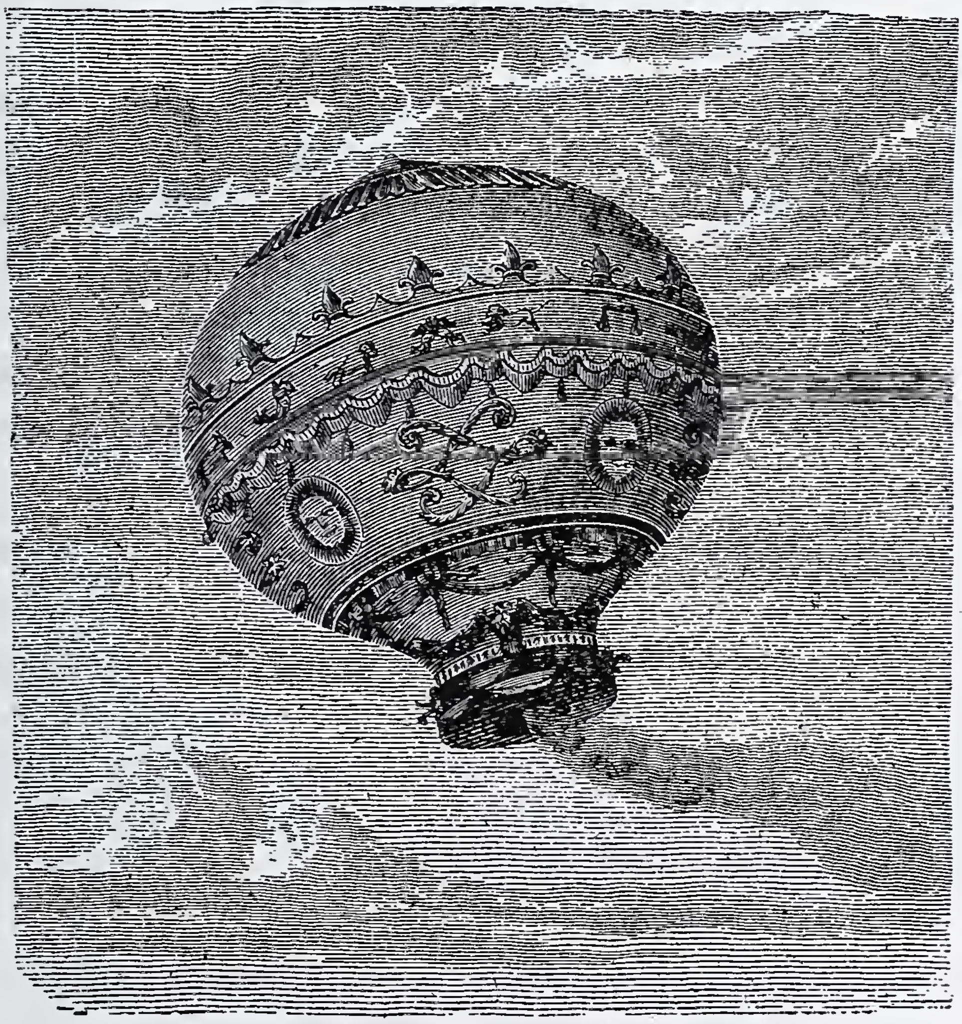
While this gas introduced into the lungs does not support respiration and therefore is grouped among the poisonous gases, if taken into the stomach it is found very agreeable. This explains the extensive use of carbonated beverages and effervescent mixtures. The so-called "soda water" is water impregnated under pressure with the gas; under a pressure of five atmospheres five volumes of the gas are held in solution, but upon release of the pressure the major part of the gas escapes with effervescence.

Carbon dioxide obtained from various sources plays an important part in baking; introduced into the dough the gas bubbles in trying to escape, especially during the baking, bring about the characteristic cellular structure of bread and cake. The carbon dioxide may be added: as ammonium carbonate which is decomposed by heat into ammonia and carbon dioxide, both gases are driven out in the baking; as yeast which in causing the fermentation of sugar produces alcohol and carbon dioxide both expelled in baking; lastly, as baking powder, containing generally three constituents: a filling material as starch or flour, the second constituent always sodium bicarbonate and finally, the third constituent, acid in character, acting upon the sodium bicarbonate liberating carbon dioxide, may be one of the following chemicals: tartaric acid, cream of tartar, calcium

superphosphate, mono-sodium phosphate or alum or aluminum sulphate; sometimes several of these last constituents are present in a baking powder. The criterion of a sample of good baking powder depends upon the percentage of available carbon dioxide which it yields upon the addition of water and the purity of the chemicals employed.

Hydrogenation of Oils.

Oils and fats consist of mixtures of liquid and solid constituents; the liquid constituents belong to the class of unsaturated organic compounds and can be made in the presence of nickel as a catalytic agent, to take up hydrogen and change into a saturated organic compound, solid instead of liquid. This change can be effected with many edible oils thereby changing them into fats.



One of the balloons of the Montgolfier brothers.

Balloons.

The first balloon sent up by the Montgolfier brothers at Ammonay in 1783; the ascensional force was furnished by burning chipped straw and wool saturated with alcohol. On August 27, 1783, a balloon of less than 600 cu. ft. capacity filled with hydro-

gen, was sent up in Paris; the populace were so excited over this appearance in the sky that, after descending, the balloon was torn into shreds; the French Government then issued a statement to the people extolling the possible benefits that might result from their use. In November, 1783, another ascension was made in which human freight was carried for the first time, two Frenchmen, De Rozier and D'Arlandes. August 24, 1804, Gay-Lussac and Biot made the first scientific observations in a balloon. September 6, 1804, Gay-Lussac made another ascension reaching an altitude of 23,000 feet at which altitude the barometer registered 12.6 inches with a temperature of —9.5 degrees F.; the temperature before starting was 31 degrees F.; the time required for the trip was six hours and distance covered ninety miles. In 1859, Wise, LaMountain, Gager and Hyde ascended from St. Louis, Mo., and in less than twenty hours descended at Henderson, N. Y., a distance of 1150 miles, averaging fifty-seven miles per hour.

Hydrogen and later illuminating gas, both inflammable and explosive with air, were used; these were recently replaced by helium, not as light as hydrogen, but noninflammable and nonexplosive; the Shenandoah, our largest aircraft, has a capacity of two million cubic feet.

Utilization of Waste Gases.

In the early days of the chemical industries many products were allowed to escape into the air causing destruction of vegetation in large areas. Many metallic sulphides were roasted and the sulphur dioxide allowed to escape; this gas is now converted into useful sulphuric acid. In making sodium carbonate, sulphuric acid acting upon sodium chloride produced the needed sodium sulphate while hydrochloric acid gas was allowed to escape, causing so much damage that legal enactments were adopted preventing this procedure; the result was such an accumulation of commercial hydrochloric acid that some outlet had to be found for it and this led to its use in making chlorine which converted into bleaching powder gave a commercial outlet. In the manufacture of coke for iron furnaces, illuminating gas and other products were not collected but at the present time there is saved the gas, ammonia, and coal tar yielding many salable products. In operations where combustible gases are produced these are utilized as fuel.

SUGAR.

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When David the Psalmist desired a simile of attractiveness, he said of the ordinances of his Lord: "Sweeter also than honey and the droppings of the honeycomb." He had never heard of sugar. You may search the Bible from cover to cover and you will find in it no mention of this common foodstuff. Wheat and barley, salt and vinegar, milk and wine, mustard and cinnamon, and many other of our foods and condiments are referred to, but of this great savory and food not a single reference.

Alexander the Great, in getting ready for that famous lachrymation over the lack of more worlds to conquer, 325 years before the Christian Era, sent an expedition into India, commanded by Nearchus. The soldiers from this invasion brought back to Greece both tales and samples of a wonderful reed, that grew in the far-off Indies, whose juice had the sweetness of honey. It was, perhaps, a knowledge of this expedition that led the old Greek botanist, Theophrastus (who was a contemporary of the great Alexander), to say: "The generation of honey is threefold; the first sort is from flowers or other things in which there is sweetness, the second from the air and falls particularly in harvest time, the third sort is from canes or reeds."

These Greek soldiers brought back pieces of the sugar cane to Europe but it is doubtful if they ever saw sugar itself. While there is reason for believing that the manufacture of sugar originated in Bengal, we have no idea of when. The first clear reference to it in European history was nearly 400 years after Alexander had died. In the first century of the Christian Era there lived in Rome a Greek physician named Dioscorides, whose writings on medicines have remained the admiration of druggists and doctors for these 1900 years. In one of his books he speaks of a substance found upon reeds in India and Arabia: "There is a sort of concreted honey found upon canes in India and Arabia. It is in consistence like salt and it is

brittle between the teeth like salt." Even 600 years later than this we find another famous medical writer, Paul of Ægina, saying: "The Indian salt is in color and form like common salt, but in taste and sweetness like honey." That sugar was known to the Asiatics many centuries before it was first brought to Europe, is shown by the very name we give it today, for the ancient Arabs had two forms of this sweet substance, one which resembled salt and which they called "sukkar" and the other in lumps which they called "kand." Thus the probable origin of the word candy.

For more than ten centuries sugar remained a curiosity known only to the learned and used only as a medicine. In the year 1353 King John II of France issued an ordinance forbidding the apothecaries of Paris from substituting honey for the good white sugar; evidently in those days sugar was a more expensive drug than honey.

As late as the seventeenth century a German doctor, named Sala, writes of the medicinal virtues: "Sugar used in a proper manner nourishes the body, generates good blood, cherishes the spirits, and makes people prolific. It is serviceable in complaints of the throat and lungs, hoarseness and defect of breathing, for ulceration of the lungs, chest, kidney and bladder. It eases pain of the intestines, it cleanses wounds and punctures in the body, it removes pains in ulcers and tumors by concocting a flux of humors . . ." which sounds like the claims of a modern patent medicine. His panegyric was not universally accepted, for we find his contemporary, Theophilus Gancieres, in 1647, writing: "Sugar and all kinds of sweetmeats are very hurtful in consumption of the lungs, and, as I conceive, the so frequent use of these things tends much to create that disease." And an English physician named Ray in 1688 says: "In regard to the scurvy, some more modern physicians, as well as those of ancient times, agree that it is produced by the too great use of sugar, and that the latter is very hurtful to the teeth and not only renders them black but causes them to decay and to loosen in their sockets, which are certain signs and symptoms of scurvy."

Just when sugar began to be used as a foodstuff is uncertain. It was an article of commerce in the fourteenth century but the price of it limited its use solely to the rich. The average price of sugar in England about the year 1400 was 1 s. 7 d. per pound, which, considering the relative purchasing power of money, would be equivalent in our day probably to two or three dollars. You who

have been excited when the price of sugar jumped to twelve or fourteen cents a pound should be grateful that you do not have to sweeten your coffee with Huyler's candy!

But before we go any further in our study of this interesting substance, let us turn aside for a moment to consider what it is we are talking about. I presume if I were to ask you, "What is sugar?", most of you would say that it was a white granular substance with a very sweet taste. Perhaps on second thought you would recall that sugar is not always white, thinking of maple sugar or a common brown sugar, but many persons are surprised to know that some kinds of sugar are not even sweet. Chemists of today recognize many kinds of sugar. For our purposes we may divide them into two groups, the simple (Monosaccharides), and the double, sugars (Disaccharides). In the first group are included dextrose or grape sugar and levulose or fruit sugar; the most important disaccharides are sucrose (cane sugar), lactose (milk sugar), and maltose (malt sugar).

Sources of Common Sugars.

MONOSACCHARIDES ($C_6H_{12}O_6$)

Dextrose (Glucose)—Honey, Grapes, Cherries, etc.
Levulose (Fructose)—Most Fruits.

DISACCHARIDES ($C_{12}H_{22}O_{11}$)

Sucrose—Sugar Cane, Beets, Maple Trees, etc.
Lactose—Milk.
Maltose—Germinating Grain.

The original prehistoric man must have derived much of his nourishment from some form of sugar. He was not fleet enough of foot, nor—until he had invented the use of weapons—sufficiently powerful to have been enough of a hunter to derive much of his food supply from animal sources. His digestive organs were not suited to utilize grass and leaves, as do the cow, deer and other herbivorous animals. He had not learned the art of agriculture and therefore had no grains, as wheat or corn, which today form the staple articles of food. He must have lived largely on roots, most of which contain relatively little nourishment, and on fruits, with an occasional feast of wild honey. In both the latter, the fruits and the honey, the nutritious part is practically all sugar. We may,

therefore, regard man as the natural sugar-eating animal, whence perhaps we have derived our extraordinary love of sweets.

There is one striking difference between the sugar-eating habits of the prehistoric savage and those of the modern flapper. Practically all of the sugars available to the primitive adult, such as those in fruit or honey, belong to the group of simple sugars, while, as I have previously said, cane sugar belongs to the group which the chemist calls disaccharides. It is a striking fact that the body is able to utilize, directly, that is, to derive energy from, only the simple sugars; cane sugar must first be broken up into simple sugars, that is, it must be digested, before its food value is available as energy.

As I have already intimated, the production of sugar seems to have originated in India. China was acquainted with sugar long before Europe and perhaps may have originated the form of sugar that we know today as rock candy, but the evidence is strong that granulated sugar originated in India. The Chinese themselves, acknowledge that they learned the art of sugar-making from the Indians. The sugar cane is native of Asia and the East Indies islands. Some writers believe that it also occurred naturally in the South Sea Islands of the Pacific and even in tropical America. But even if this view be correct, there is no evidence that the aboriginal inhabitants ever made sugar from it. It must be noted that contrary to the ideas of old Dioscorides and his contemporaries, white sugar is a manufactured substance; the cane juice will not crystallize merely by exposure to the air and does not concrete on the reeds, as they asserted.

The knowledge of how to prepare sugar from cane juice which originated in Bengal, no one knows when, spread to China in about 700 A. D. and through Persia to northern Africa in the ninth or tenth century. From their home in Africa the Moors carried sugar culture to Spain in the latter part of the tenth century. The European peoples, however, did not begin to make sugar, at least in any quantity, until about the time of the discovery of America. Fourteen years after Columbus landed on the island of Haiti, the sugar cane was transplanted there from the Canary Islands to the West Indies and shortly afterwards was established the first factory for manufacturing sugar in the new world, which was soon to supply Europe with such quantities of the "sweet salt" that it might become an important article of diet for even the poor. From this

beginning the cultivation of sugar cane and the manufacture of sugar spread rapidly through the West India Islands and to the neighboring sub-tropical coast of the American Continent.

While time will not permit me to consider in any detail the sources and manufacture of sugar, a brief reference to the general principles may not be out of place. The name "cane sugar," as convenient as it may be, is not strictly accurate, because this sugar is obtained not only from the sugar cane but also largely from beets, and, to a small extent, from maple trees and a species of palm tree, as well as another grass-like plant known as sorghum. We in this country are apt to think of sugar as a product of the tropics because the bulk of our sugar comes from the island of Cuba and the neighboring tropical regions. It may surprise some to know that before the war Germany was the greatest sugar-producing nation in the world, their annual crop being over 2,700,000 tons, all of which was extracted from beets; while the annual production of Cuba at that time was about 2,400,000 tons. Today the Cuban production is over three million tons.

The major portion of the sugar consumed in the United States comes from the sugar cane grown in the island of Cuba, although upwards of a million tons of sugar is produced from beets grown in this country as well as some from sugar cane and small quantities from sorghum.

The sugar cane is usually grown from cuttings rather than from seeds. It requires from one to two years, according to climate and soil, to reach maturity. When it is full grown, it is harvested by cutting close to the ground and the cane hauled to nearby mills, where the juice is expressed by rolling between iron cylinders. It is, however, not possible to obtain all the juice, more than one-fourth of it ordinarily being left behind. The expressed juice consists of about 80 per cent. of water, 17 or 18 per cent. of crystallizable sugar and small amounts of other vegetable substances. To this raw juice is added a small amount of lime and it is allowed to stand until a scum rises to the top. The clear underliquid is drawn off and boiled to a thick syrup, which is then allowed to cool in shallow vessels, during which process a portion of the sugar crystallizes out. The liquid syrup remaining is then drawn off and constitutes what we call molasses. This first molasses may be further concentrated and made to yield a portion of the sugar which it still holds. The crystallized parts separated in this way constitute what is known as

raw sugar, or muscovado, and is usually shipped to the refineries in the United States, some of the largest of which are here in Philadelphia. In these refineries the yellowish raw sugar is purified by filtering a hot solution, decolorized with bone black and recrystallized by boiling in vacuum pans.

Through the successive stages of curiosity, drug and condiment, sugar has become one of our most important foodstuffs. In order to appreciate the advantages and disadvantages of sugar as a food, it is necessary to digress for a moment to consider the different kinds of food that are necessary for our health. Our bodies are engines which derive their power from burning fuel which is obtained from the food we eat. In addition to fuel our diet must furnish us with material for replacing parts of the machinery that become worn out. In other words, foods are of two kinds: those which furnish energy and those which are useful as body builders. The body-building foods are of two sorts; first, those which contain a complex substance known as protein, the basis of meat; and secondly, certain mineral elements such as lime, iron, salt, potash, etc. It is very evident that the growing bodies of children need a larger amount of these foodstuffs, because not only must there be sufficient to make good the wear and tear upon their engines, but there must be enough to furnish material for enlarging the engine. While a certain amount of energy can be derived from the protein elements of our diet, the chief fuel foods may be divided into two groups: first, the fats; and secondly, a class of substances known to the chemists as carbohydrates, which includes the various forms of starch and the sugars.

It must be understood that most of the things we eat contain several of these four elements of food. Milk, for example, contains all of them: protein, mineral, fat and sugar. Meat contains protein and fat and some mineral but no carbohydrate. Bread, at least if made from whole wheat, contains all the necessary body builders, both protein and mineral, as well as a large amount of carbohydrate, but no fat; ordinarily we make up for this lack in bread by spreading it with butter, which is pure fat.

Most of our ordinary foodstuffs contain a large amount of material that is not nutritious in any way. When a food contains very little waste material we say it is a highly concentrated food. Chemists, for the sake of measuring the nutritional value of different foods, have invented a unit of measure which they call the

calorie; they speak of a certain quantity of this or that food representing so many calories. Perhaps I can give some vague idea of what the calorie is by saying that the ordinary adult requires about 2000 to 3000 calories a day, according to the amount of exercise he takes.

While practically all foods contain more or less waste material, there is an enormous difference in the concentration of various articles of diet. For instance, a pound of potatoes contains approximately 500 calories; a pound of beef, about 1100 calories; a pound of onions less than 200 calories; a pound of milk about 350 calories. There are few foods which come on our table that are as concentrated as sugar. One pound of sugar represents over 1800 calories. It is also a relatively cheap food. A hundred calories of roast beef costs about three cents; a hundred calories of milk costs about two cents; a hundred calories of sugar costs about half of one cent. Moreover, sugar is a food which is easily utilizable by the body. Every householder knows that some substances are more easily combustible than others. A pound of wood has less fuel value than a pound of coal, but it is much easier kindled and burns much more rapidly; kerosene is of no greater fuel value than paraffine, but it is much more inflammable. So we find certain foods which can be much more easily burned up in the body, or, as the chemist expresses it, are readily assimilable. The ease with which these foods are consumed bears no necessary relation to their food value. Sugar is, of all the ordinary foodstuffs, probably the one most easily and most rapidly burned up.

The promptness with which sugar is utilized by the body is due, at least in part, to the fact that it is already half digested. It is, however, not entirely prepared for the nutrifying of the body. As I have already mentioned, among the carbohydrates the only ones whose nourishment is directly available to our tissues are the simple sugars, levulose and dextrose. It is necessary, therefore, that cane sugar be changed from a disaccharide to a monosaccharide. This alteration, which the chemist calls "inversion" of the sugar, is brought about by certain digestive secretions in the intestines. In the digestion of starches there is first formed a disaccharide, probably maltose, which is then inverted into dextrose and the latter is carried by the blood to the muscles and other organs of the body. The blood always contains a certain amount of sugar in the form of dextrose. After a meal, containing either sugar or starch, the

amount of sugar in the blood is increased beyond that which is immediately needed by the tissues; this excess is removed and stored up in the liver to be gradually given back to the blood during the periods between meals. If large amounts of sugar are eaten, the absorption from the intestines into the blood stream may become so rapid that the liver is unable to remove the excess, in which case sugar will be excreted by the kidneys and appear in the urine.

The disease known as diabetes, which is characterized by the presence of sugar in the urine, is due to the inability of the body cells to burn up sugar. While the presence of sugar in the urine, which occurs after eating large amounts of this food, is a very different condition from true diabetes, there is strong reason to believe that the continual excessive use of sugar may eventually lead to this disease.

Let us sum up now the points in favor of sugar as a food. They are: its high concentration, relatively low cost and ease of assimilation. While cane sugar is a comparatively inexpensive foodstuff, it is by no means the cheapest and but little importance is to be given to this point. The lack of waste, that is, the high food value in proportion to weight, makes sugar a valuable addition to the diet when transportation facilities are limited. For this reason it usually forms part of the emergency ration for marching troops or among Arctic explorers. Because of the rapidity with which it is absorbed, sugar has a remarkable restorative effect in conditions where the nutritive supply to the tissues has been temporarily exhausted. These conditions may occur not only as the result of starvation but also after strenuous muscular exertion. When a man is in a state of physical exhaustion stimulants, like tea, may cause a temporary benefit, but sugar will not only promptly relieve the symptoms of depression but is a true curative agent because it furnishes the hungry tissues of the body their needed nourishment.

On the other hand, sugar has certain striking disadvantages or rather limitations. Indeed, some of the conditions which we have quoted as advantages of sugar, such as the lack of waste and the ease of assimilation may, under some conditions, become undesirable instead of advantageous factors. In the first place, it is to be noted that sugar contains absolutely none of the body-building elements, neither protein nor mineral. A man would starve to death on a diet composed of sugar alone, provided he did not die of indigestion. This lack of body-building elements is especially impor-

tant with growing children. Our American love of sweets which manifests itself in the enormous consumption of candy, and of the so-called soda water drinks, is injurious enough to adults but still more harmful to children. Not only does sugar fail to provide the proper building body elements, but, like the dog in the manger, prevents the child from taking the proper quantity of more complete and essential foods. Because of its high fuel value and ease of combustion, it meets, at least temporarily, energy requirements and thereby lessens the demand for more useful foods; but more than this the sweet taste has a very manifest tendency to kill the appetite. Many a mother has been able to detect the forbidden use of candy by the lack of appetite for supper.

Besides this negative deficiency, it has certain positively injurious qualities. Strong sugar solutions are locally irritant to the mucous membrane, and large quantities of sugar or of candy, especially taken without other food, are therefore liable to irritate the lining of the stomach and give rise to symptoms of indigestion. It has been experimentally found that large quantities of sugar have a distinctly retarding effect upon digestion. Moreover, as is well known, sugar is a very easily fermentable substance. In the process of fermentation not only is its own food value destroyed, but it also gives rise to compounds that are actively injurious. This decomposition may take place anywhere in the digestive tract until the sugar has been absorbed. If it occur in the mouth the acids formed by fermenting sugar will attack the enamel of the teeth and give rise to a focus of decay. A dental friend of mine said to me the other day: "I can tell a candy fiend as soon as I look in his mouth." The injurious action of candy on the teeth, especially of children, is an old story; I read not long ago a book published by a Dr. Short, of London, in 1750, in which occurs the following sentence: "Sugar on distillation contains an acid penetrating spirit which rots the teeth of its excessive consumers and exposes them to bad fevers." The decay of the teeth is, in my opinion, due not alone to the direct local action of the sugar and its decomposition products, but also in part to the effect on appetite and consequent neglect of those foods which contain the mineral substances requisite for the upbuilding and maintenance of tooth structure.

Of course there are many diseased states, such as gout, diabetes, dyspepsia, etc., in which the use of sugar is directly injurious.

But the consideration of these would take us too deeply into the realm of medical science to be profitable for the present purposes.

As far as the normal healthy individual is concerned I may sum up my views on the use of sugar as a daily foodstuff are as follows: In moderate amounts sugar is a cheap and pleasant addition to the diet whose use is on the whole rather beneficial than harmful. On the other hand the large quantities consumed by the average American are likely to have an undesirable effect on the health. The per capita consumption of sugar in the United States is about eighty-five pounds a year, while in France and Germany it is less than fifty pounds, and in Italy only eleven. A pound and a half of sugar a week for each of us, adult or infant, seems rather an excessive amount. Just how much of this is consumed in soft drinks I do not know, but I may remind you that the ordinary glass of "soda water" represents about one and a half ounces of sugar; one soda a day would mean twenty-seven pounds of sugar a year.

CHOCOLATE.

By E. Fullerton Cook, Ph. M.

When one combines in food or drink something that appeals to both the imagination and palate, perfection has been reached. Who would not be stimulated, if as they drink their cup of steaming chocolate their thoughts could be taken back to the year 1519 when Cortez, the Spanish conqueror of Mexico, returned to England. The gathering of his friends about him and their interest can be pictured, as he tells them of this strange food and drink unknown to Europe but in common use among the Aztecs for at least several centuries.

He told of how the perfect beans were used as a means of exchange, and were called "blessed money" since they could not be hoarded or hidden underground and so did not induce avarice, and that one hundred thousand tons of it were used annually in the royal palace of Mexico during the days of prosperity among the Aztecs. He told of how the gift of the cacao seed, which was said to have grown in Eden for the delight of men and gods was attributed directly to Divine Providence.

He explained the method of preparation which not only included its roasting and grinding but also the addition of vanilla and sugar, both native to their country, and also told of a combination which had been devised in the form of froth to be held in the mouth without swallowing until it automatically passed into the stomach. This was served to the Emperor, Montezuma, in goblets of gold or tortoise-shell beautifully carved; the goblets, after a single use, being tossed into the lake surrounding the palace. Fifty jars or pitchers of chocolate were prepared daily for the consumption of the Emperor's household.

The planting of the trees by the Aztecs was accompanied by a festival and a special ceremony in which the blood of some animal was sprinkled on the ground, that usually employed being from a dog having a spot of chocolate color.

As the fragrance and comfort of the drink permeates one, a series of pictures come. One sees Antonio Carletti, in 1606, a

lover of chocolate, learning the method of manufacturing, teaching it to Italian friends and passing it on to the French and other European nations, but it is hard to picture chocolate as being considered a means of influencing the passions and to realize that even the much read *Spectator* in 1712 would appear with an article warning the public not to use it during the great carnival.

One sees the students at Oxford, as early as 1650 sitting together and discussing their problems over their cups of coffee and chocolate and finally in 1659 a monopoly being granted for the making and selling of chocolate in France.

All chocolate originally came from Central America but in 1679 came the first crop from a French Colony in Martinique, and its cultivation was begun in the Philippine Islands in 1680. Its main production today is in cultivated territory, distant from its origin.

Fruit on Cacao Tree.

During all of these earlier periods the cost of chocolate was necessarily high, yet there are many references to its use and great popularity, notably in connection with the "Chocolate Houses" of England where, in 1820, duty was paid on about 280 pounds of imported chocolate.

In those days the total production of the cacao bean was small compared with the present estimated annual world output, which exceeds four hundred million pounds.

Can anything be lovelier than the cacao tree, with its tall, slender trunk, often twenty-five feet in height, its small bright red flowers, springing from the main branches or from the trunk itself and, as in most tropical plants, the flowers and fruits, in various stages of growth, being found simultaneously upon the same tree. The fruit requires about four months to become mature and during this time changes from green to yellow and finally to a rich, golden red, when ripe, producing a striking color effect.

The cacao bean from which chocolate is made is a seed from a peculiar fruit or pod growing by a slender stem from the trunk or larger branches. Botanically, the cacao tree was named in 1720 by Linneaus "Theobroma Cacao," signifying "Food of the Gods." Possibly in selecting this title he was influenced by treatise on Chocolate by Buchot, a French physician, written in 1684, in which he described chocolate, "As an invention more worthy of being called food of the gods than nectar or ambrosia."

Several other species of the genus Theobroma have been cultivated but the "Theobroma Cacao" supplies by far the larger proportion of the beans.

Longitudinal and Cross-Section of Pods, Showing the Arrangement of the Cocoa Beans or Seeds.

Even the picture of a cacao plantation is most attractive. The trees are planted regularly, about twenty feet apart, in rich, loamy soil, where the temperature remains between 69 and 89 F. throughout the year. It is necessary that there should be ample moisture but good drainage. As the trees do not thrive in too great heat it is necessary to plant other trees which will shade the cacao tree. Imagine the ideal spot on which to found a cacao plantation being a well-sheltered vale, covered with large trees, protected by mountain spurs from prevailing winds, well watered, and yet well drained, with a good depth of deposit of decayed alluvial soil, on which rests a thick vegetable matter, easy of access, and in a district distant from lagoons or marshes, for the proprietor's health.

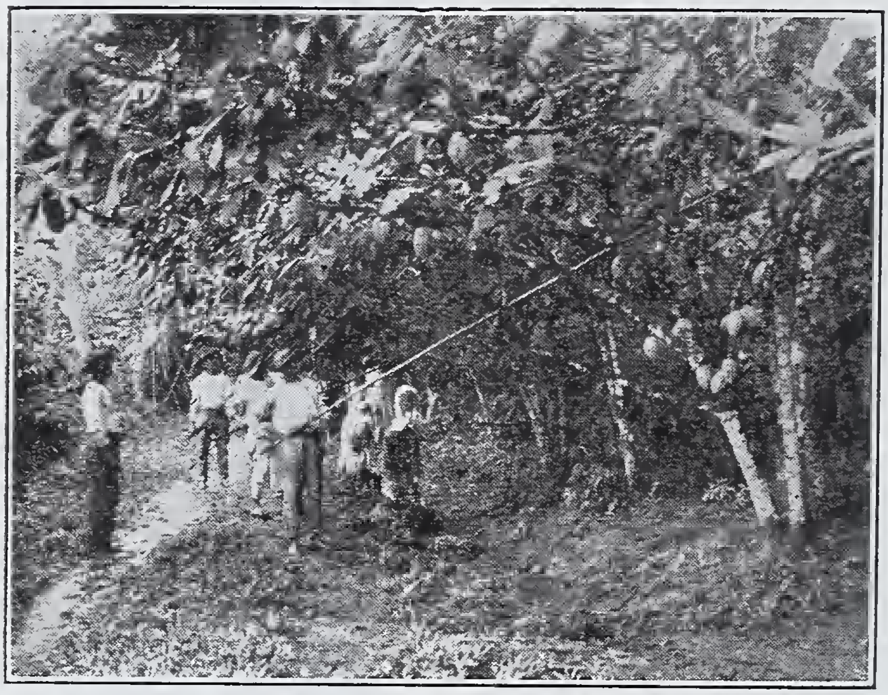
These ideal conditions have been found in Mexico, in Costa Rica, in the islands of the West Indies, in Ceylon, and in certain parts of Africa.

The trees begin to bear fruit when three or four years old and if well cared for will produce regular crops for fifty or more years.

The fruit is cut and gathered when ripe, usually twice a year, a hand knife, or, for the higher branches, a knife on a bamboo pole being used.

It is said that great care is necessary in cutting the fruit that the blossoms may not be injured since the new flowers are usually found at the point where the fruit joins the tree.

The fruit resembles a large cucumber, being from 8 to 10 inches in length with ridged sides. The shell is about a half-inch thick and contains a white, sweetish pulp, not unlike a canteloupe and encloses from twenty to forty almond-shaped seeds which when properly cured represent the "Cacao beans" of commerce.

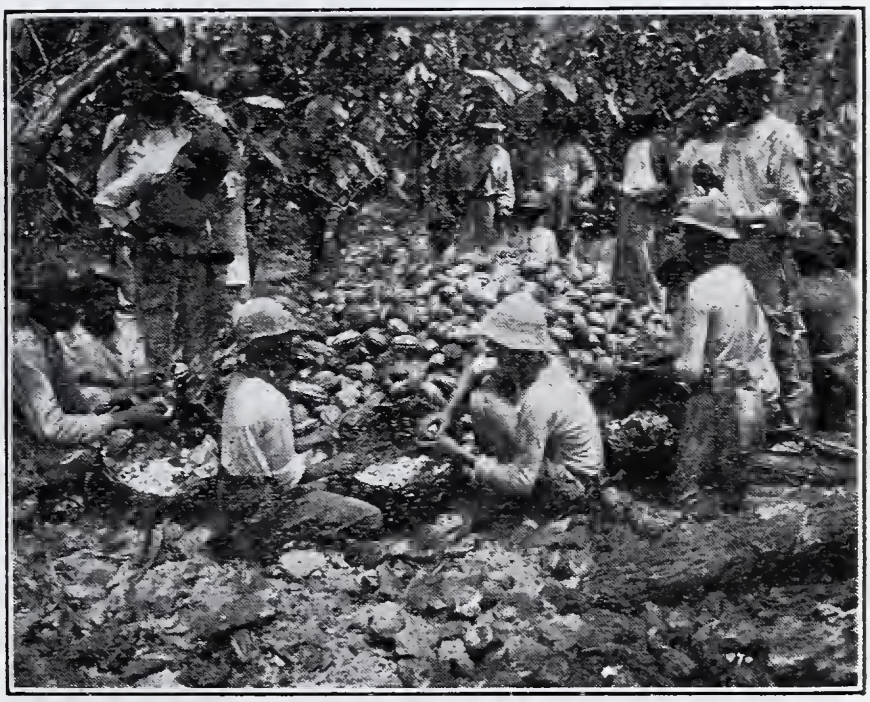


Harvesting the Cocoa Pod.

When the outer shells have been broken or cut and the seeds and pulp removed it is difficult to separate the pulp and this is usually brought about by fermentation, in specially constructed houses. The seeds are placed in vats and fermentation proceeds under regulated temperatures until completed. The practical planter, recognizing the proper condition and color. The ultimate flavor and value largely depends upon the skill with which this process has been conducted. From nine to twelve days are required for fermentation and curing, the beans changing during the process from almost white to a rich brown, with extensive chemical modification such as the conversion of starch to soluble dextrin, the hydrolizing of the astringent matter, which is largely reduced, and the loss of some alkaloid. Treatment with alkali has been proposed instead of fermentation but the latter process, when properly controlled, still produces the finest flavor in the beans.

When the proper color and flavor has been developed by fermentation, the beans are usually washed and then dried as quickly as possible, preferably by exposure on large trays to the heat of the sun. Drying is sometimes done artificially.

The very names of the chief commercial sources of the cacao bean are imagination appealing. Think of Ecuador, Venezuela Surinam, Brazil, Cuba, Haiti, San Domingo, British Guiana, British Honduras, Nicaragua, Colombia, Mexico, Guatemala, Trinidad, Granada, Guadeloups, Martinique, St. Lucia, Dominica, St. Vincent, and Jamaica. In Central America and the West Indies. San-Thorme, Cameron, Gold Coast and Fernando Po in Africa, and the islands of Java, and Ceylon.*



Cutting Open Pods to Obtain the Beans.

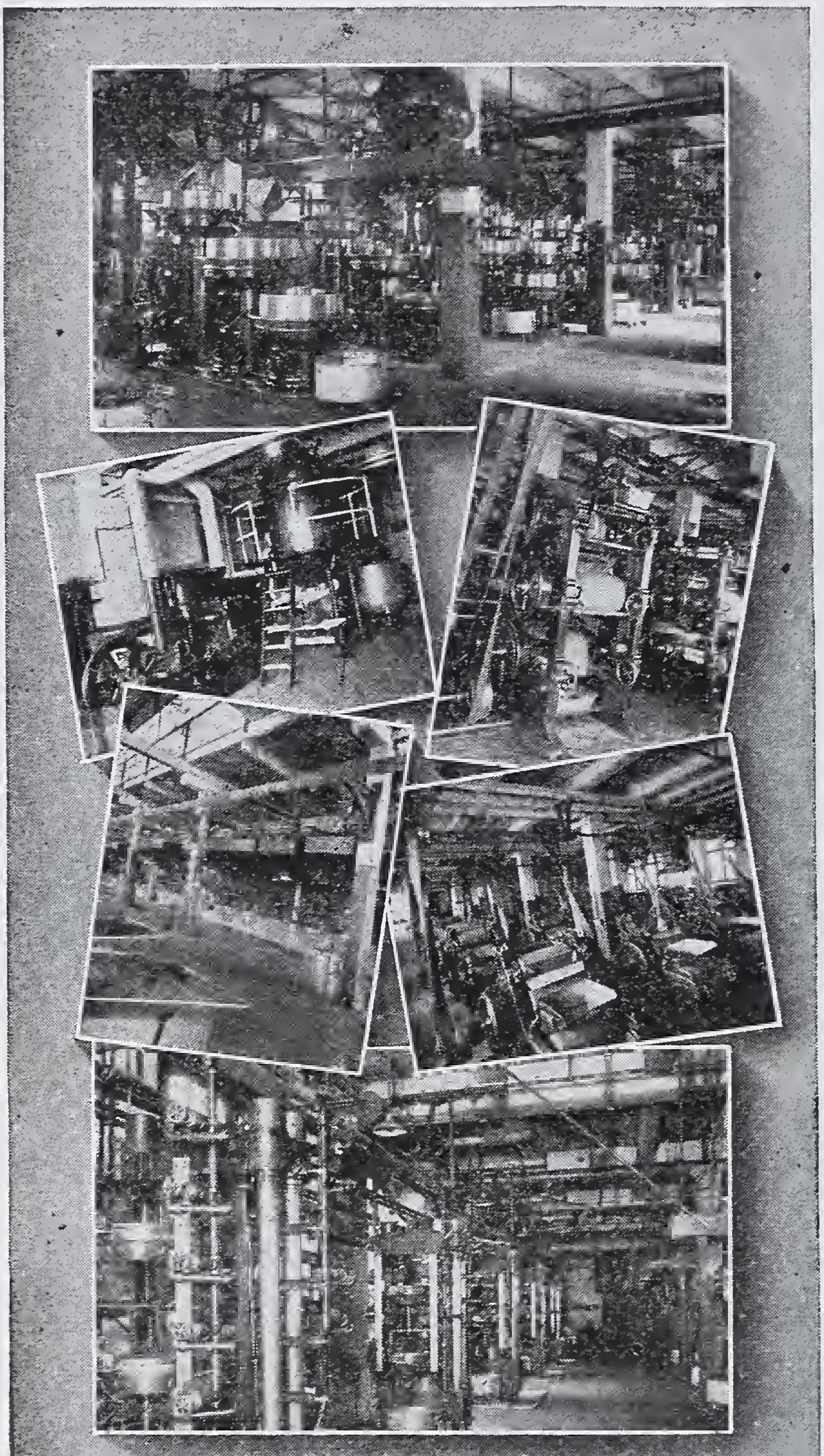
A marked variation will be found in the quality of beans from different countries and also in the several grades obtainable in any one market.

The best grade comes from selected stock, and must be correctly fermented, quickly washed and carefully dried to avoid moulds. Sometimes the beans are "clayed" (covered with a reddish clay), notably is this true in Trinidad, the claim being made that the clay prevents insect attack.

In many other varieties the beans are "polished" by dancing on

*Approximate production in 1917: In South America: Ecuador, 40,000 tons; Venezuela, 20,000 tons; Surinam, 3000 tons; Brazil, 55,000 tons. In Central America small quantities from Guatemala, Mexico and Costa Rica. In the West Indies: Haiti, 2000 tons; San Domingo, 24,000 tons; Trinidad, 31,000 tons; Granada, 5000 tons; Jamaica, 3000 tons; Guadeloups, 1000 tons; Martinique, 500 tons; Dominica, 300 tons; St. Vincent, 100 tons. In Africa: San-Thomé, 30,000 tons; Cameron, 4000 tons; Samoa, 1000 tons; Gold Coast (Acera), 90,000 tons; Fernando Po, 3500 tons; Nigeria, 15,500 tons; Ceylon 3600 tons; and smaller amounts from Java, Celebes, Temate, Aruboina, Sumatra and Baili.

the dried beans, thus removing adhering pulp. If the beans are clayed, or improperly cleaned, there is considerable loss in weight due to impurities and their subsequent removal. The beans should be brittle, easily crushed and the kernels or "nibs" readily separable from the shells.



A few Interior Views of the Factory

An expert can readily determine the quality or grade of beans by examining, smelling and tasting them.

Even the chemist will get a picture from the analysis of the kernels of cacao beans, which show about 40 per cent. of fat, and about 1.37 per cent. of theobromine. The latter is an alkaloid similar chemically and in physiologic action to caffeine, the alkaloid from tea and coffee.

The husks or shells also contain theobromine, about 0.62 per cent., and this is the commercial source of theobromine.

A part of the skill of the manufacturer of chocolate consists in his ability to properly blend the cacao beans from various sources to secure the desired flavor. The beans, which are marketed in large sacks, holding about 250 pounds must first

be cleaned. In this process, sticks, stones, clay, pieces of clothes, and other foreign substances, are removed. The beans are then roasted, very much as coffee is roasted, to develop the aroma, modify the color, oxidize some of the tannin, and make it possible to readily remove the husk. The roasting is conducted in revolving drums at a temperature between 100 and 135 C., the process being continued until the desired effect is obtained. When the beans have acquired the proper flavor, they must be quickly cooled to prevent further change caused by contained heat. This is accomplished by transferring them to a cooler so arranged that cold air can be blown through the mass of beans.

The beans are now passed through rollers to crack the husk and kernel and then winnowed, or subjected to a blast of air, to separate the broken kernels, now technically called "nibs," from the shells, the modern machines affecting almost complete separation.

A germ-separating machine is also an important piece of apparatus since the presence of the germ lessens the value of the finished chocolate as it is slightly bitter and extremely gritty when ground.

The "nibs" are now ground through a series of heavy mills to reduce them to the finest possible subdivision and smoothness, even the best grades being greatly lessened in value if not finely enough ground.

A few moments after the nibs pass under the rollers they melt to a thick dark liquor due to the heat of friction liquefying the oil which constitutes about half the weight of the beans.

After passing through several grinding stones (most manufacturers object to iron or steel mills), the "chocolate liquor" may now be placed in hydraulic presses and much of the oil removed, about 18 per cent. remaining in the pressed cake. This cake when powdered constitutes the "Cocoa" of the market and when treated with alkali produces the so-called "soluble cocoas."

Most cocoa beverages are made from this powdered cocoa.

The oil which separates as a clear liquid solidifies at the ordinary temperature and constitutes Cacao Butter or "Coco Butter," which enters into many toilet preparations for application to the face and hands and forms the base for most suppositories. Cacao butter may also be obtained from the roasted or unroasted beans by the use of volatile solvents.

Chocolate liquor of higher grade is not pressed to remove the fat but will be further ground in heavy mills until free from all harshness, then conditioned by heating for some hours at about 130 degrees Fahrenheit, and finally treated for special application.

Sometimes powdered or evaporated milk is added to produce "milk chocolate." Again sugar and vanilla may be used to make "sweet chocolate" or nuts to produce "chocolate almonds," etc.

The chocolate liquor so prepared is usually moulded into the commercial forms such as cakes, bars, "buds," etc., and must be suitably wrapped or boxed for sale.

A special chocolate liquor is prepared for coating candy, a process which calls for an exact temperature and consistence at the time of coating, which long experience alone can provide.

A word should be added concerning the food value of chocolate. This remarkable substance is not only a confection, although it is one of the most delightful of candies. It is more than this, however, it contains such large amounts of fat that it becomes one of the most valuable nutritive foods and the alkaloid theobromine adds its stimulating and refreshing qualities. This well explains the reason why soldiers, arctic explorers and others exposed to the rigors of a campaign or exploration, provide themselves with an abundance of this highly concentrated food which is also a gratification and pleasure to consume.

It will thus be seen that in this remarkable substance, Chocolate, nature has almost excelled its many other lavish gifts by providing an ideal food, a delicious drink, the perfect confection, and a medicine to stimulate without doing harm.

Would one believe it possible to find all these pictures in a cup of chocolate? Perhaps they will come to you with your next cup of the fragrant drink.

THE DRUGS OF THE NORTH AMERICAN INDIAN.

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The drugs of our first landlords, the Aborigines of North America, represent an interesting group of products derived from the three great natural kingdoms. While the actual medicaments employed differ with the tribes and the regions in which they dwelt, many similarities are evident in their medical practices. Indian medicine of the past has been largely a mingling of charms and herbs. Where the Indians are in contact with the white man, many of the old remedies are slowly and stubbornly giving way to the newer curative agents of modern science.

To the uneducated Indians, the cause and nature of disease are for the greater part mysteries. Every illness that cannot be plainly associated with a visible cause is regarded as the effect of an introduction into the body of noxious objects either by a sorcerer or by offended or ill-disposed supernatural beings. These objects they believe produce the pain, discomfort and other symptoms of the illness.

Every Indian tribe had, and in many cases still has, its medicine men and medicine women who are distinguished in designation, responsibilities, and in influence over the people. The ordinary procedure of the medicine man was about as follows:

He first inquired into the symptoms, dreams, and transgressions of tabus of the patient, whom he examined, and then gave his opinion as to the nature of the ailment. This was generally mythical. He then prayed, advised or sang to the accompaniment of a rattle, and made passes with his hand, occasionally moistened with saliva, over the part affected. Finally, he placed his mouth over the most painful spot and sucked hard to extract the immediate principle of the illness. This result he apparently accomplished, often by means of sleight of hand, producing the offending cause in the shape of a pebble, thorn, hair, splinter, or other object, which was then thrown away or destroyed. Finally he administered a medicine and often with it, a protective fetish.

The fetishes used included peculiar shaped stones, feathers,

claws, lightning-riven wood, hair, and pieces of pottery ornamented with mythic animals, representations of the sun, lightning, etc. These were believed to embody a mysterious power capable of preventing disease and counteracting its effects. There were numerous variations of this method according to the requirements of the case. If the case would not yield to simple treatment, a healing ceremony was sometimes resorted to. If all means failed, the medicine men suggested a witch or wizard as the cause. The designation of some known person as the culprit often placed his life in jeopardy. Often, when the medicine man lost several patients in succession, he was suspected by his tribe either of having been deprived of his supernatural power or having become a sorcerer, the penalty for which was usually death.

The medicine man was usually well compensated for his services. In early days, if an acceptable gift did not accompany the call for these, he demanded and received his fee in advance from the patient or family. Payment, then, was usually made in the shape of wampum, moccasins, the best bow, arrows, furs, venison or other food.

Of the many drugs constituting the Indian materia medica, by far the greater number are derived from the plant kingdom. The majority represent roots and rhizomes and entire plants, although barks, leaves, stems, flowers, fruits, pollen and seeds were also employed. These are used in the fresh or dry state. Usually only a single drug is used for an ailment but among some tribes up to four drugs are combined in a single remedy. Relatively few animal and mineral drugs were used. The preparations which the Indians made from these drugs included decoctions, infusions, ointments, plasters, lotions and liniments. The greatest number were decoctions. Boiling was often done in dishes of birch or some other bark placed on coals, hot ashes, or stones heated by fire beneath, or heated stones were dropped into the liquid.

Before the arrival of the early colonists, the North American Indians were acquainted with cough and cold remedies, emetics, cathartics, diaphoretics, vermifuges, astringents, alteratives, stimulants, narcotics, and antiseptics. They did not know how these produced the desired effect; they simply knew they cured.

Some of their medicines were used because of a real or fancied resemblance to the part affected, others for traditional reasons, some

because of a supposed supernatural beneficial effect, while others were left with the patient as protective fetishes. The ceremonies which accompanied the administration of many of the remedies varied with the tribes and healers. Some of these like the Mountain Chant which was practiced by the shamans or medicine men of the Navaho were occasions where people gathered together for a jolly good time at the patient's expense.

In return for the liberality, the patient hoped to incur the favor and help of the gods, the praise of the priesthood and social distinction from fellow tribesmen. This particular ceremony lasted nine days and was very costly. It included an elaborate program of dances and chants and little treatment.

Let us now examine a representative number of the drugs used by the North American Indians and the purposes for which they were employed.

Vegetable Drugs Used by the North American Indians.

1. *Balsam Fir.*—The Penobscot Indians of Maine prepared an ointment by incorporating the oleoresin of this tree with animal fat. The oleoresin is obtained from vesicles on the bark and also by skimming it from the surface of water in which the crushed bark is boiled. The oleoresin or balsam of fir was applied externally by various northern tribes to cuts and sores. The Ojibwa tribe of Minnesota used it internally as a remedy for gonorrhea and for colds in the chest. They also scraped the bark from the trunk and prepared a decoction of it for inducing perspiration.

2. *Milfoil.*—The Winnebago employed an infusion of this herb to bathe swellings. A wad of leaves as well as some infusion was placed in the ear for earache. The Pah Utes make a tea from the plant which they drink for weak and disordered stomach.

3. *Sweet Flag.*—In early days the Indians mixed the powdered rhizome and roots with powdered red willow bark and used the mixture for smoking. All of the Indians employed the rhizomes as a carminative. The Plains tribes drunk a decoction for fever and colds and chewed it as a remedy for cough and toothache. They often employed it in the smoke treatment for colds. Among the Teton-Dakota, warriors chewed the rhizome to a paste which they rubbed on their faces to prevent excitement and fear when confronted with

an enemy. The Cheyenne tribe believed the rhizome when chewed and rubbed on the skin to be good for any malady. They tied portions of the rhizome to the dress, blanket or necklet of their children to keep away the night spirits. The leaves were worn by various tribes as garlands.

4. *Maidenhair Fern.*—A decoction of this plant was used by the Cherokee in the treatment of chills and fever. A poultice prepared from this and usually some other fern was administered for rheumatism along with the decoction. The medicine men of this tribe explain that the fern is rolled up in the young plant but unrolls and straightens out as it grows and consequently a decoction of ferns causes the contracted muscles of the rheumatic patient to unbend and straighten out in like manner.

5. *Peyote.*—The drug obtained from this cactus is commonly known under the names of "peyote," "pellote" and "mescal button." It consists of the dried flowering top or crown of a succulent, spineless cactus, having the shape of a carrot, with a depressed globular head and a tapering tap root. This drug was used by the ancient Aztecs of Mexico who termed it "teonanacatl" or "sacred mushroom," on account of the resemblance of the dried buttons to peltate fungi. They imparted their knowledge concerning its use to the Chickimecas who in turn gave instructions to our Apaches, Comanches and Kiowas. It occurs in commerce as dried brownish disks, representing transverse slices of the crown, from 1 to 1.5 inches in diameter and about one-quarter inch in thickness; when dry it is hard and brittle but upon moistening becomes soft; its odor is peculiar and disagreeable and its taste unpleasantly bitter. From time immemorial this narcotic has been used in ceremonies of worship among the Mexican Indians. From these the Peyote religion has spread northward until now it has become a popular cult posing as a Christian religion among many of the Plains Indians. Its followers have become so strong in Oklahoma as to establish there a Peyote Church which is chartered under the name of the Native American Church.

The ceremony connected with a Peyote meeting is usually that of prayer, performed as an invocation for the recovery of some sick individual. It is held in an enclosure called a tipi and usually begins at night and continues until sometime the following morning. As many men as can sit comfortably within this "sanctum" participate

while the women prepare the sacred food. In the center of the tipi a fire is kept burning, inclosed within a crescent-shaped mound on the top of which rests a sacred peyote. The opening prayer is delivered by the chief priest, after which four peyotes are distributed to each participant, who chews and swallows them. The sacred songs now begin to the accompaniment of the drum and rattle, each man in turn singing four songs. These continue all night, there being interims of prayer and further distributions of peyote, with a peculiar baptismal ceremony at midnight. From ten to forty peyote disks are eaten by each individual. The drug is said to first usually produce a peculiar excitement of the brain, expressing itself in a feeling of contentment and a friendly attitude toward the world in general. This feeling is soon followed by a derangement of the centers of sight in the brain, which causes, particularly when the eyes are closed, a kaleidoscopic flow of scenes of great beauty and color effect. The Indians interpret these pleasing visions as a reflection of the beauties of paradise. The effect is heightened by the weird songs, the constant sound of the drum and rattle and the glare of the fire. The meeting closes with a feast in which the women participate with the men.

Peyote is also taken in the form of decoction or tea as well as in capsules of the ground disks. An excessive dose of the drug has a tendency, often, to cause unpleasant scenes in which hideous monsters and beings of distorted shape appear. The Indians are said to interpret these visual hallucinations as denizens from the abode of evil spirits sent as a warning to them to forsake their evil ways.

6. *Spikenard.*—Many of the tribes used the rhizome and roots as a carminative as well as an expectorant and antiseptic in coughs, pains in the chest and mortification. The rhizome and roots and horseradish roots were ground and made into a poultice which was applied to the feet in general dropsy. The juice of the berries and oil of the seeds were poured into the ears of those afflicted with deafness.

7. *Jack-in-the-pulpit.*—The corm was used by the Pawnee who powdered it and dusted the powder on the top of the head and temples for headache. The powdered corm was also applied as a counter-irritant for rheumatism and muscular pains.

8. *Virginia Snakeroot.*—The Cherokee Indians employed the rhizomes and roots for a number of purposes. The drug was chewed

and spit upon the wound to cure snake bites. It was bruised and placed in a hollow tooth for toothache and held against a nose made sore by constant blowing, in colds. A decoction was blown upon the patient for fever and drunk for cough.

9. *Canada Snakeroot.*—The Indians of Canada and Maine employed the rhizome and roots as a remedy for stomach ills.

10. *Pleurisy Root.*—The Penobscot Indians employed the root as a diaphoretic and cold medicine. The root was eaten raw by other tribes for pulmonary troubles. It was also chewed and put into wounds or pulverized, when dry, and blown into wounds and also applied as a remedy to old obstinate sores. In the Omaha tribe a certain member of the Shell society was the authorized keeper of this medicine. It was his duty to dig the root and distribute bundles of it to the members of the society. The ceremonials connected with the digging, preparation, consecration and distribution occupied four days. The No. 4 is dominant in all ritual and in all orientation in space and time among the Plains tribes, just as the No. 7 is dominant with other Indian tribes; whether four or seven be the dominant number depends on whether the four cardinal points of the horizon are given pre-eminence or whether equal place is given also to the three remaining points, the Zenith, the Nadir and the Here.

11. *Rattlesnake Fern.*—The Ojibwa bruised the root of this fern and applied it to cuts.

12. *Sweet-scented Water-Lily.*—The astringent rhizomes were greatly esteemed by Indian squaws who prepared a decoction from them for use as an internal remedy and injection or wash for leucorrhœa. The Penobscot and other tribes living in territory bordering the Atlantic seaboard used them as an application in the form of poultice to suppurating glands.

13. *Blue Cohosh.*—The rhizomes and roots were used for a number of ills by many tribes of Indians. They were esteemed their most valuable parturient. An infusion of this drug given a week or two before confinement is said to have rendered delivery rapid and painless. The drug was also employed as a remedy for rheumatism, dropsy, uterine inflammation and colic. The Omaha tribe considered a decoction of this drug as their greatest febrifuge.

14. *Pipsissewa.*—This plant was used by the Aborigines as an application to open sores and also internally as a tonic and diuretic.

15. *Water Hemlock.*—The roots of this poisonous herb were eaten by such Indians as were tired of life and desirous of an early demise.

16. *Black Snakeroot.*—This was a favorite remedy among the Aborigines of the eastern half of North America. The rhizomes and roots were used by them for rheumatism, disordered menstruation and slow parturition. They were also used against bites of poisonous snakes.

17. *Kinnikinnick.*—The inner bark of this dogwood was scraped off and dried for smoking by most of the tribes. The tobacco mixture of the North American Indians called "Kinnikinnick" is composed of scrapings of the bark of this species mixed with tobacco in the proportion of about one in four. The Cree Indians of Hudson Bay used the bark in decoction as an emetic in cough and fever. They made a black dye by boiling it with iron rust. A scarlet dye was made by several tribes by boiling the rootlets with water.

18. *Flowering Dogwood.*—At the time of the discovery of America, the Delawares and other tribes used the bark for fever and colds.

19. *Showy Lady's Slipper.*—The Penobscot tribe employed the rhizomes and roots of this orchid as a sedative in nervous disorders.

20. *Smaller Yellow Lady's Slipper.*—The Cherokee employed a decoction of the rhizomes and roots for worms in children. In this liquid was placed some stalks of a chickweed. From the appearance of the red fleshy stalks of the latter, it was supposed to have some connection with worms.

21. *Jimson Weed.*—The Indians of Southern United States and Mexico knew the narcotic properties of this annual herb before the arrival of the white man. The Virginia Indians gave it as an intoxicant in initiatory ceremonies. The Walapac of Arizona used the decoction of leaves, roots and flowers to induce frenzy and exhilaration. The Zuni of New Mexico use the roots as a narcotic and anæs-

thetic and employ the powdered blossoms and roots externally in the treatment of wounds and bruises. They formerly used Datura seeds to divine the hiding place of some precious object or to detect the thief who had stolen it. Some of the Yuman tribes employed the leaves only as a narcotic. Among the Aztecs of Mexico the seeds of a Datura were held sacred and the spirit of the plant was invoked to expel evil spirits.

22. *Canada Fleabane.*—The Cree Indians used a decoction of this composite for diarrhœa. The Zuni used the ray florets only. These they crushed between the fingers and inserted in the nostrils to cure rhinitis.

23. *Button Snakeroot.*—This plant was popular with many tribes as a remedy for snake bites. It was combined with Blue Flag as a febrifuge and diuretic.

24. *Wahoo.*—A decoction of the inner bark was drunk by the Winnebago squaws for uterine trouble.

25. *Boneset.*—A decoction of this plant was regarded by the native tribes as one of the most powerful remedies for fever and colds.

26. *Joe Pye Weed.*—The Cherokee employed a decoction of the root for difficult urination.

27. *Jalap.*—The Mexican Indians used the tuberous root of this plant as a drastic purgative.

28. *Cranesbill.*—The rhizome was used by several of the eastern tribes as an astringent in diarrhœa. The Cherokee employed a decoction of this drug and Chicken Grape for washing the mouths of their children in thrush.

29. *Bowman's Root.*—The emetic virtues of the root of this herb were known to many of the Indians who made the early colonists acquainted with its properties. The Cherokee tribe also used the root which they pounded up and applied as a poultice to swellings.

30. *Grindelia.*—A decoction made from the entire plant was drunk by the Indians of Mexico and Southern California as a cure

for colds. The Ponca tribe used a decoction for consumption, while the Teton-Dakota administered it to their children as a remedy for colic. The Pawnee boiled the tops and leaves and made a wash for saddle galls and sores on horse's back.

31. *Witch Hazel.*—Many of the tribes used an infusion of the bark for bruises, piles and hemorrhages.

32. *Hepatica.*—The Cherokee made a tea from this herb or chewed the root for coughs. Those of this tribe who dreamt of snakes took a decoction of this plant and the Walking Fern. This produced vomiting and it was believed the dreams did not return.

33. *Cow Parsnip.*—The tops are used by the Winnebago medicine men in the smoke treatment for fainting and convulsions. A decoction of the root is employed by the Omaha tribe as a remedy for intestinal pains and as a physic. The Pawnee scrape or powder the root and after boiling apply the mass to boils as a poultice.

34. *Hop.*—The fruits were made into a tea by the Teton-Dakota which was used for fever and abdominal pains. This and other Plains tribes chewed the root and applied it to wounds, sometimes in combination with the roots of a Ground Cherry and Meadow Anemone.

35. *Yellow Puccoon.*—This valuable plant was known to the Cherokee before the arrival of the early settlers. This tribe had used its rhizomes and roots with success as a tonic, stomachic and as an application to sore eyes and ulcers. A yellow dye for clothing and implements of warfare was also prepared by them from this drug.

36. *Waterleaf.*—The roots were boiled by the Ojibwa who took the liquid for internal pains, especially those occurring in the back or chest.

37. *Cassine.*—This shrub also called Yaupon, was the source of the celebrated ceremonial "black drink" of the Aborigines. The Creek Indians of Florida discovered it and imparted their knowledge of its valuable stimulating properties to the white settlers of Florida, Georgia and the Carolinas. The American Indians pre-

pared the leaves for keeping by drying or rather parching them in a pottage pot over a slow fire. They drank large quantities without sugar for health and pleasure. They claimed it restored lost appetite, strengthened the stomach and gave them agility and courage in war.

René de Laudonnière, leader of the ill-fated Huguenot expedition to Florida (1564) observed the use of the "black drink" as practiced by the Indians living at the mouth of the St. John's River, Florida. Later, Le Moine, in his narrative of this expedition, gave the following account of the ceremonies accompanying the preparation and dispensing of the "black drink":

"The chief and his nobles are accustomed during certain days of the year to meet early every morning for this express purpose in a public place, in which a long bench is constructed, having at the middle of it a projecting part laid with nine round trunks of trees for the chief's seat. On this he sits by himself for distinction sake; and the rest come to salute him, one at a time, the oldest first, by lifting both hands twice to the height of the head and saying, 'Ha, he, ya, ha, ha.' To this the rest answer, 'Ha ha.' Each as he completes his salutation takes his seat on the bench. If any question of importance is to be discussed, the chief calls upon his lauas (that is, his priests) and upon the elders, one at a time, to deliver their opinions. They decide upon nothing until they have held a number of councils over it, and they deliberate very sagely before deciding. Meanwhile the chief orders the women to boil some cassine, which is drunk prepared from the leaves of a certain root and which they afterwards pass through a strainer. The chief and his councilors being now seated in their places, one stands before him, and spreading forth his hands wide open, asks a blessing upon the chief and the others who are to drink. Then the cupbearer brings the hot drink in a capacious shell, first to the chief, and then, as the chief directs, to the rest in their order in the same shell. They esteem this drink so highly that no one is allowed to drink it in council unless he has proved himself a brave warrior.

"Those whose stomachs reject the drink are not intrusted with any difficult commission or military responsibility being considered unfit, for they often have to go three or four days without food; but one who can drink this liquor can go twenty-four hours

afterward without eating or drinking. In military expeditions also the only supplies which they carry consist of gourd bottles or wooden vessels full of this drink. It strengthens and nourishes the body."

38. *Blue Flag.*—By most of the Indian tribes the rhizome of this perennial herb was highly esteemed as a remedy for gastric disturbances. The Omaha and Ponca tribes powdered it, mixed it with water or saliva and dropped this preparation in the ear for earache. They also prepared a paste from it which they applied to sores and bruises.

39. *Red Cedar.*—The leaves were used by the Cree Indians as a diuretic. The Ojibwa employed the bruised leaves and fruits as a headache remedy while the Plains tribes boiled together the fruits and leaves and drank the decoction for cough. For colds in the head and nervousness the twigs were burned and the smoke inhaled. The Oglala tribe used a decoction of the leaves internally in Asiatic cholera. The Omaha and Ponca heated the twigs on hot stoves in their purificatory rites.

40. *Indian Tobacco.*—The dried leaves of this Lobelia were smoked by many tribes as an emetic.

41. *Canada Moonseed.*—The rhizomes and roots of this climber were used by various tribes for scrofula. The Pawnee employed it for sore mouth.

42. *Indian Pipe.*—The juice of this plant is mixed with water and applied to sore eyes by several tribes who esteem it as a soothing and often curative medicine.

43. *Tobacco.*—The leaves of various indigenous species of *Nicotiana* were used as a drug before the discovery of America. Columbus, on landing at St. Domingo in 1492, discovered the natives smoking cylinders of tobacco leaves. The drug was so extensively used by the Indians that the early settlers found it under cultivation as far north as the St. Lawrence River.

The "Tobacco Nation," inhabiting nine villages just below the southern shores of Lake Huron, cultivated tobacco on a large scale and sold it to other tribes who used it in smoking. At meetings

of ambassadors, treaties of peace and councils of nations, the calumet or pipe of peace was circulated. In the south, tobacco smoking often accompanied the ceremonial of the "black drink."

While smoking is the most common way of employing this drug, it is by no means the only method. The Tewa tribe place tobacco leaves on or in a tooth to relieve toothache and use tobacco snuff to cure a discharge from the nose. To cure a cough, they place tobacco, oil and soot in the hollows of the patient's neck and make a cross of tobacco on the chest.

44. *Prickly Pear.*—The pith of this plant was thrown on live coals by the Apache and the smoke allowed to pass into the open eyes.

45. *Ginseng.*—Ginseng was known to a number of tribes, the root being alone used. The Cherokee chewed the root and ejected it on the painful area. They drank a decoction of this drug for headache, cramps and female troubles. The roots were employed by several western tribes in combination with parts of other plants and red paint as a love charm.

46. *Poke Berry.*—The American Aborigines handed down the medicinal uses of this plant to the white settlers. They employed the root as an emetic and rheumatism remedy and the fruit for a red stain which they used in decorative work.

47. *May Apple.*—The Aborigines used the rhizome and roots as a cathartic.

48. *Seneca Snakeroot.*—The Seneca tribe was the first to make the white man acquainted with the virtues of this plant. They employed the root in decoction as a remedy for coughs and colds as well as for the bite of a rattlesnake. They also used the leaves which were made into an infusion and given for sore throat.

49. *Solomon's Seal.*—The Cherokee bruised the root, then heated it and applied it as a poultice to remove swelling.

50. *Wild Black Cherry.*—The inner bark of this tree was applied to external sores. It was prepared for use either by first

boiling, bruising or chewing it. An infusion of the inner bark was given by the Indians to relieve pain and soreness of the chest.

51. *White Oak.*—The root bark and inner bark of the trunk of this and other oaks was used by many of the tribes in the form of decoction for diarrhœa.

52. *Castor Oil Bean.*—The Maricoba tribe crushed the seeds, mixed them with water and heated the mixture. One or two drops of this was placed in the ear for earache.

53. *Early White Rose.*—The roots of this or other species of wild roses were steeped in warm water by most of the tribes and the liquid applied to inflamed eyes.

54. *Rumex.*—The root and green leaves of the Yellow Dock were used by many tribes as a medicine and dye. The Cheyenne drank an infusion of the powdered root for hemorrhage of the lungs. They also moistened the powdered root and applied it as a poultice to wounds and sores. The Ojibwa applied the bruised or crushed root to sores and abrasions. The Teton-Dakota crushed the green leaves and bound them on boils to draw out the suppuration.

55. *Sanguinaria.*—The rhizomes and roots of this plant constituted the "Red Puccoon" of the Indians generally who used it both as a red dye for painting their faces, clothing and implements of warfare and as a love charm. The fresh rhizomes and roots, containing a red milk juice were used for decorating their skin, while wearing apparel was often boiled with these parts. Bachelors of some of the tribes, after rubbing some of the red milk juice on their hands, would contrive to shake hands with girls they desired; if successful in this, after five or six days, these girls are said to have been found willing to marry them.

56. *Mad-dog Scullcap.*—This herb was long used by the Penobscot, Iroquois, Cherokee and other tribes, in decoction, as a remedy for numerous ailments. It is listed as an ingredient in one of the sacred formulas of the Cherokee. A decoction of this plant together with *Scutellaria pilosa, Hypericum punctatum* and *Stylo-*

santhes elatior was drunk by the women of this tribe to promote menstruation. It was also used by the men of the tribe as a wash to counteract the ill effect of eating food prepared by a woman in the menstrual condition. It was also drunk for diarrhœa and used with other herbs for breast pains.

57. *Indian Pink.*—The rhizomes and roots of this plant were valued as a vermifuge among the Aborigines before the discovery of America. The colonists of the South received their information concerning its properties from the Cherokee and Osages who also used it as a sudorific and sedative.

58. *Dandelion.*—The Tewa ground the dried leaves of this herb and used the powder in dressing fractures. They also mixed this drug with dough and applied it to bruises.

59. *Bethroot.*—The rhizomes and roots of this plant were used for women's complaints by the Indians of Missouri and Canada. The freshly cut rhizomes were held to the nose and the acridity inhaled for nose bleed.

60. *Hemlock.*—The Penobscot tribe used finely powdered hemlock bark to relieve and prevent chafing.

61. *Cat Tail.*—Every part of this plant was used by various Indian tribes for some ailment. The Cherokees crushed the roots by pounding or chewing and applied the mass as a poultice to sores. The Omaha tribe used the roots and ripe blossoms for scalds. For this purpose the root was powdered, wetted and spread as a paste over the scald. The ripe blossoms were then applied as a covering and the injured part bound, so as to hold the dressing in place. The Cheyenne used an infusion of the powdered roots and white bases of leaves for the relief of abdominal cramps. The Dakota, Omaha-Ponca, Winnebago and Pawnee applied the down as a dressing to burns and scalds. They also rubbed it on the skin of infants to prevent chafing. Newly born babies were laid in a mass of the down.

62. *Slippery Elm.*—The fresh inner bark was chewed for cough by many of the tribes. It was boiled by the Omaha who used the decoction as a laxative. This tribe as well as the tribes of

Canada have long cooked the inner bark with all of their animal fats in rendering out the grease. These tribes have realized that the bark gives a desirable flavor to the fat and a preservative quality, preventing the rendered grease from becoming rancid.

63. *American Hellebore.*—The Indians of New England used the rhizome and roots as an ordeal in the selection of their tribal chiefs. The one whose stomach withstood its action the longest was decided to be the strongest of the party and entitled to command the rest.

64. *Culver's Root.*—The Ojibwa used a decoction of the rhizome and roots as a purgative.

65. *Cascara Sagrada.*—Some of the Indian tribes of the northwest employed this bark in decoction as a purgative.

66. *Sarsaparilla.*—The Mexican Indians employed the roots of the Mexican species in decoction as an alterative.

67. *Rhatany.*—The Indians of southern Texas and northern Mexico extensively employed the roots of a *Krameria* as an astringent.

68. *Aconite.*—The Otomi tribe pasted the leaves of an unidentified species of Aconite over the painful area, in treating neuralgia, and on the temples for headache.

69. *Red Baneberry.*—The Ojibwa, Sagamore, Penobscot and other tribes employed a decoction of the root for pains in the stomach. On account of its characteristics at certain seasons of the year, it was considered male and given only to men and boys; at other seasons, on account of the color of its fruits or some other peculiarity, it was considered female, and given only to women and girls.

70. *Aletris.*—The Aborigines living along the eastern seaboard used a decoction of the rhizome and roots of the Unicorn Root as a stomachic, tonic and emmenagogue.

71. *Pulsatilla.*—Bachelors of the Ponca tribe rubbed the tops of the native species into the palms of their hands as a love charm.

The Pawnee gave the entire plant to horses as a stimulant. Other Indian tribes used the crushed leaves as a counter-irritant in rheumatism and neuralgia.

72. *Bearberry.*—The leaves were dried by several aboriginal tribes and ground with tobacco or red willow as a smoking mixture. A decoction of the stems, leaves and berries was drunk by many tribes for pain in the back and sprained back.

73. *Artemisia.*—Practically every native species of Artemisia was popular with the Indians of this continent. An Indian who had broken some taboo or who had touched any sacred object must bathe with Artemisia. It was always considered proper to begin any ceremonial by using Artemisia in order to drive away evil influence. Old timers used various Artemisias for exorcising evil powers. They employed sweet grass or cedar twigs as incense for attracting good powers.

There are Indians today who still use any of the Artemisias as incense for this purpose at Christmas, Easter, Pentecost and on the occasion of funerals.

Decoctions of various species of Artemisia are highly valued by the tribes for stomach troubles, colds, worms, and other ailments.

74. *Trailing Mahonia.*—The rhizome and roots of this Barberry has been a favorite drug of the California Indians. A decoction is taken as a remedy for general debility and as an appetizer.

75. *American Wormseed.*—The entire herb was employed by the Aborigines in a tea for painful menstruation.

Animal Drugs.

Rattlesnake.—Among the Cora tribe, a patient suffering from consumption hunted a rattlesnake and cut off its head and tail before it became angered. The body of the snake was then washed, toasted and dried and a piece of it taken at each meal. The Papago also used the flesh of the rattlesnake for the same disease but prepared it differently. They dried the flesh and powdered it and mixed a portion of this powder with the patient's food while it was being cooked and without his knowledge. The Pima applied

the fat of this animal to wounds induced by the rattlesnake. The Hopi and other southwestern tribes treated such wounds with an application of the ventral surface of a disemboweled snake. A secret decoction of herbs was also given to the patient.

Beaver (Castor).—The Penobscot tribe used the preputial follicles of the beaver as a remedy for irregular menstruation.

Pig.—The Cora tribe employed the snout and blood of a recently killed pig in the treatment of snake bites. The raw surface of the snout was applied to the wound, and the blood, diluted with warm water, was drunk.

Cricket.—The insects were dried, and ground, and taken internally as a remedy for dysuria by the Papago.

Lizard.—This reptile was used by the Tarahumare and Cora tribes who employed it in the form of decoction for bodily pains.

Spider.—Spider's eggs were used by the Apache as medicine. The Mescaleros and other tribes applied the spider's web to cuts to stop bleeding.

Owl.—The Pima employed the feather of this bird for curing a person who steadily loses flesh and feels ill.

In addition to these, the oils and fats of buffalo, bear and other animals were used as liniments and as bases for ointments.

Mineral Drugs.

Red Ochre.—The Navaho and other tribes mixed this with fat and rubbed the ointment on the skin to prevent sunburn.

Slaked Lime.—The Cora applied slaked lime as a dressing to gunshot wounds.

Ashes.—The Hopi blow wood-ashes on an inflamed surface to counteract the supposed fire which causes the ailment.

Clay.—The White Mountain Apache women employed the red, barren clay from beneath a camp fire to induce sterility.

The Indians of North America had a more extended acquaintance with the materials of medicine than has generally been believed. While some of their practices were shamanistic and a number of their remedies worthless, they employed many drugs of real value. Among the drugs which they used the following are officially recognized either in the present editions of the United States Pharmacopœia or the National Formulary:

Seneca Snakeroot, Pleurisy Root, Poke Root, Yellow Dock, Jalap, Blue Flag, Beth Root, Geranium, American Hellebore, Black Snakeroot, Golden Seal, Bloodroot, Virginia Snakeroot, May Apple, Pink Root, Aletris, Lady's Slipper, Angelica, Canadian Hemp, Spikenard, Canada Snakeroot, Trailing Mahonia, Blue Cohosh, Purple Cone Flower, Culver's Root, Cascara Sagrada, Sarsaparilla, Wild Black Cherry, Slippery Elm, Prickly Ash, Sassafras, Dogwood, Wahoo, Butternut Bark, White Oak Bark, Rhatany, Blackberry Root Bark, Yerba Santa, Jimson Weed, Bearberry, Witch Hazel, Pipsissewa, Arbor Vitae, Grindelia, Lobelia, Boneset, Scullcap, Pulsatilla, Life-Root, Verbena, Elder Flowers, Hops, Vanilla, Pumpkin Seeds, Larch Agaric and Turpentine. A number of others have appeared in former editions of these works.

From the Red Man of this continent, our forefathers gained knowledge of many of the uses of these drugs which has been passed down to the present generation as a valuable heritage.

FREE PUBLIC LECTURE COURSE.

1924—1925.

Philadelphia College of Pharmacy and Science,

145 North Tenth Street.

The lectures will begin at 8.15 P. M.

This is the fourth season of the effort of the Philadelphia College of Pharmacy and Science to contribute to the educational welfare of the community at large by means of a series of popular scientific subjects.

The lectures are delivered by members of the Faculty of the institution and are abundantly illustrated by experiments, lantern slides and specimens.

Those which have been presented during the past three seasons have been attended and enjoyed by many interested persons.

They are given in a form which is simple and understandable and which is of interest alike to the person who has been technically trained along particular lines and to the one who is simply interested in scientific subjects in general.

These lectures are subsequently published in book form. Two volumes are now available and may be secured for one dollar each from the office of THE AMERICAN JOURNAL OF PHARMACY, 145 North Tenth Street, Philadelphia.

First Lecture **Thursday Evening, October 9, 1924.**

ARCTIC AND TROPICAL PENNSYLVANIA.

By Henry Leffmann, A. M., M. D.

Lecturer on Research, Philadelphia College of Pharmacy and Science; Hon. Professor of Chemistry, Wagner Free Institute of Science, etc.

The testimony of the rocks is that the region in which Pennsylvania is included has undergone extreme variations of climate. At one time warm, moist conditions produced tropical plants such as tree ferns, in abundance. From these much of the coal now be-

ing mined was produced. At another time an ice sheet nearly half a mile deep covered a portion of the area, and the torrential waters from the melting of this modified the land. The "terminal moraine," characteristic of glaciers, can be traced in many parts of the State. Volcanic actions of great severity have also occurred and left distinct traces. Lantern slides illustrating these conditions will be shown.

Second Lecture **Thursday Evening, October 23, 1924.**

BRIDGE CONSTRUCTION.

By George Rosengarten, Ph. D.

Instructor in Physics, Philadelphia College of Pharmacy and Science.

The bridge is an important object of interest to the community. Different types of Bridge Truss will be considered with a study of the stresses and strains to be resisted. The use of the 10,000,000-pound testing machine. The cantilever and suspension bridges as types suitable for long spans—the concrete arch. A review of the important bridges in Philadelphia past, present and future. The new Delaware River Bridge will be considered in detail.

Third Lecture **Thursday Evening, November 6, 1924.**

CHEMISTRY IN AND ABOUT THE HOME.

By Freeman P. Stroup, Ph. M.

Professor of Chemistry, Philadelphia College of Pharmacy and Science.

Someone has said that an insurance agent with a knowledge of chemistry is better equipped for his job than is the one who is ignorant of the subject. Surely, then, a cook, who is daily dealing with chemicals (all materials are chemical in nature) and chemical processes (most cooking and baking processes involve chemical reactions), ought to be better equipped if possessed of a working knowledge of the materials which are handled, and the changes which they undergo under the influence of heat. The lecturer will

endeavor to give in easily understood language some of the principles underlying many household operations, particularly kitchen operations, with the hope that his feminine hearers may become even more adept practitioners of the culinary art than they are now, and that his masculine hearers, having been given a clearer insight into the difficulties that confront the kitchen chemist, will be a little more charitable in their judgment of the products of the household "laboratory."

Fourth Lecture **Thursday Evening, November 20, 1924.**

CHEMISTRY AND COLOR.

By J. W. Sturmer, Ph. M., Phar. D.

Dean of Science, Philadelphia College of Pharmacy and Science.

Color is a mystery. To be sure, we know something about the rainbow, and more recently science has revealed much concerning the color-effects exhibited by films of oil, wings of insects, and the feathers of birds. We know about pigments, dyes and the coloring matters in flowers. And now science is searching for the real answer to the question, Why is a red substance red, or a blue one blue?

Paints and Pigments provide fascinating topics for study from several standpoints.

The lecture will deal with certain advances in the study of colors, and will be illustrated with lantern slides and with experiments.

Fifth Lecture **Thursday Evening, December 4, 1924.**

THE MINERAL AND VEGETABLE RESOURCES OF THE SEA.

By Ralph R. Foran, P. D.

Assistant Professor of Technical and Analytical Chemistry, Philadelphia College of Pharmacy and Science.

The economic importance of the products of the sea is not ordinarily known or appreciated. To many, the ocean is simply a bar-

ren waste used as a means of transportation and as a source of rainfall.

Aside from the fishery products yielded by the ocean, there are many other products of vegetable and mineral origin which contribute to the welfare of man. Thus, sea-water itself contains much more than common salt. Thirty-two of the eighty known elements have been found dissolved in it. Seaweed or kelp may be made to yield more than a score of valuable substances.

The lecture, which will be illustrated, will deal with all of the resources of the sea, other than the "sea foods."

Sixth Lecture **Thursday Evening, December 18, 1924.**

THE ROMANCE OF CHEMISTRY.

By Charles H. LaWall, Ph. M., Sc. D.

Chemist to Food Bureau, Pennsylvania Department of Agriculture; Professor of Pharmacy, Philadelphia College of Pharmacy and Science.

The word Chemistry comes indirectly from a root word meaning "black." There is warrant, therefore, for its having been classed with the black arts in its early days.

The search for the Philosopher's Stone and the Elixir of Life, the *ignes fatui* of the "alchemists" as the practitioners of the art were at first called, were responsible for many real discoveries of value.

Kings, queens, emperors, monks and scholars all vied with each other in studying its principles and conducting experiments in the hope of amassing great wealth or of achieving eternal youth. All of these are now passed away, but the trail of these early Spagyrists or practitioners of the Hermetic art is full of interest and of romance.

The lecturer will take his audience over this trail, which leads down to the period when the empiric art was metamorphosed into the science of chemistry.

Seventh Lecture Thursday Evening, January 8, 1925.

THE UPS AND DOWNS OF NITROGEN.

By Ivor Griffith, P. D., Ph. M.
Physiological Chemist, Stetson Hospital, Philadelphia; Assistant Professor of Pharmacy, Philadelphia College of Pharmacy and Science.

Free Nitrogen is abundant. Free articles generally are—but it isn't of much account in living processes.

Fixed Nitrogen is comparatively scarce, and for that reason Dame Nature is very conservative with it. Over and over again she uses it. For example—what Fixed Nitrogen she loans to the living human body—when death comes with its earthen basket—Nature wants her Nitrogen back again to use in other quarters. Scientists call this bartering of Fixed Nitrogen "The Nitrogen Cycle." On the other hand, when civilization practices that uncivil finale, the cremation of the dead—civilization is committing a chemical crime. Nature is robbed of her rightful possession.

But things are better than they used to be. Time was when the world's capital of Fixed Nitrogen was surely shrinking away. Man, however, has changed the scheme—he can now, by chemical process, convert the Free Nitrogen of the air into Fixed Nitrogen. Germs were doing a bit of this long before man knew how—and the thunderstorms and the heat of the Summer Sun—but they never made enough to balance the amount that man wasted by burning the forests and his brothers.

But things are different now—and that will be the story of the "Ups and Downs of Nitrogen."

Eighth Lecture Thursday Evening, January 22, 1925.

THE WATER SUPPLY AND ITS RELATION TO HEALTH AND DISEASE.

By David Wilbur Horn, Ph. D.
Professor of Physics and Physical Chemistry, Philadelphia College of Pharmacy and Science; Professor of Inorganic Chemistry, Wagner Free Institute of Science.

Water supply as a chemical problem has existed since time immemorial. Experience has taught that some waters are not well

adapted to continued use by men; and that some are. The chemical explanation of this problem has in part been worked out.

Water supply as a sanitary problem arises as primitive, nomadic conditions are exchanged for those of populations concentrated in fixed residential centers. From the time of the great sanitary awakening in England down to the present, this sanitary problem has been under study. The answers arrived at to date are included obviously or by implication in the arrangements for the water supplies of our large cities. This sanitary problem changes as decades pass, and the future water supply demands present consideration.

The lecture will cover various factors in these problems, past, present and future, of the water supply.

Ninth Lecture **Thursday Evening, February 5, 1925.**

WHY SOAP?

By E. Fullerton Cook, Ph. M.

Professor of Operative Pharmacy and Director of the Pharmaceutical Laboratory, Philadelphia College of Pharmacy and Science.

The use of soap is so universal and so much a commonplace part of our civilization that it required a world war to bring a realization of its importance. In those countries where the inexorable demand for war material eliminated soap, its absence constituted one of the greatest hardships.

Although made by a chemical process, its origin is lost in antiquity. It is mentioned in the writings of Aristophanes (434 B. C.), also by Plato (348 B. C.), and is referred to in the Bible in the book of Jeremiah.

The making of soap in a modern factory has become an important branch of chemistry and its successful marketing a complicated and important business.

Its history and an entertaining review of the modern methods of manufacture will be presented with many illustrations and samples.

Tenth Lecture Thursday Evening, February 19, 1925.

WHAT SHALL WE EAT?

By Horatio C. Wood, M. D.

Professor of Materia Medica, Philadelphia College of Pharmacy and Science.

The word "vitamine" is on everybody's tongue, some of the restaurants give on their menu-cards the "Caloric value" of each dish; but the users of these words ofttimes have only very hazy notions as to what these figures mean. This lecture will discuss the uses of food as a source of energy and bodily repair; the classification of the various foodstuffs and the kinds and quantities required for health, the relative nutritive value of our common foods, the advantages of a mixed diet and other similar questions about diet which all who are interested in maintaining their health should know.

Eleventh Lecture Thursday Evening, March 5, 1925.

CHALK AND ITS CHEMICAL RELATIVES.

By Edward J. Hughes, P. D.

Assistant Professor of Chemistry, Philadelphia College of Pharmacy and Science.

The world is supplied with vast quantities of the material of which chalk is composed. The chemical name of this substance is calcium carbonate. The limestone rocks of the earth, the coral formations of the sea, the chalk cliffs of Dover, the stalactites and stalagmites of Mammoth Cave, are a few examples of the multifarious forms in which calcium carbonate is found.

The lecture will be an attempt to present an interesting outline of the chemical history of calcium carbonate and its wide diversity of application to the affairs of everyday life.

Lantern slides, experiments and specimens will be shown.

Twelfth Lecture Thursday Evening, March 19, 1925.

CHEMICALS WE SHOULD KNOW.

By Frank X. Moerck, Ph. M.

Director of the Technical Chemistry Courses, Philadelphia College of Pharmacy and Science.

With the progress of science and the popular application of discoveries in which chemicals perform important functions, a knowledge of the properties of the employed chemicals in so far as they may affect health and property becomes necessary; in fact, a duty. There are many substances in use today by the laity which have been used for many years by scientists and other trained persons; these substances will be so considered that the untrained persons will obtain the necessary knowledge to use them safely.

Chemicals may be used as means of generating power, heat, light and electricity, or they may be used as fire-extinguishers, cleaning fluids, insecticides, etc.

Thirteenth Lecture Thursday Evening, April 2, 1925.

PRACTICAL DISINFECTION.

By Louis Gershenfeld, B. Sc., Ph. M.

Professor of Bacteriology, Philadelphia College of Pharmacy and Science.

What is the difference between an antiseptic and a bactericide? What are some of the most efficient disinfectants that one can employ about the home? How are they to be used? Do you know that there are discrepancies in the reports and advertisements of many of the products you are relying upon to kill deadly organisms? Do you know the limitations of the commonly used disinfectants? Are you familiar with the fact that the efficacy of these destructive agents is largely dependent upon the mode of application, the kind of material or environment to which they are applied, and other important facts which one must know to obtain the desired results?

In this lecture information will be given concerning the use of disinfectants and the lecture will point out the properties and uses of some of the disinfectants commonly employed about the home.

Fourteenth Lecture **Thursday Evening, April 16, 1925.**

CONTROL OF GROWTH IN PLANTS AND ANIMALS.

By Arno Viehoever, Ph. D.

Professor of Biology and Pharmacognosy and Director of the Botanical Gardens, Philadelphia College of Pharmacy and Science.

An attempt will be made in this lecture, with the aid of lantern slides, to illustrate various phases of outstanding importance governing our life as well as that of other organisms. The following topics will be touched upon briefly: 1. General Discussion on Growth, Form and Function. 2. Essential Nutrients and Specific Substances Governing Growth. 3. Growth in Unicellular Plants and Animals (Normal and Abnormal—Immortal Organism). 4. Growth in Higher Organized Forms (Plants, Animals and Man—Normal and Abnormal, including Cancer). 5. Experimental Growth (a. Determination of Sex; b. Regeneration, Replacement of Tissue; c. Rejuvenation [regaining of youth]). 6. Biological and Economical Significance.

Fifteenth Lecture **Thursday Evening, April 30, 1925.**

ANIMAL AVIATORS.

By Marin S. Dunn, A. M.

Assistant Professor of Botany, Philadelphia College of Pharmacy and Science.

This lecture will discuss the following topics in relation to flight: 1. Those animals which possess the power of flying or gliding movements. Included here are such forms as insects, birds, bats, the flying fish, the flying frog, the flying lizard, the flying lemur, the flying squirrel, etc. 2. Means of flight—the nature of wings. 3. Significance of flight. 4. The possible origin of flight.

The lecture will be illustrated by charts, specimens and lantern slides.

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